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DEVELOPMENT OF A PAVEMENT CONDITION RATING PROCEDURE FOR ROADS,--ETC(U)  
JUL 79 M Y SHAHIN, S D KOHN

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July 1979

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DEVELOPMENT OF A PAVEMENT CONDITION RATING  
PROCEDURE FOR ROADS, STREETS,  
AND PARKING LOTS

VOL II: DISTRESS IDENTIFICATION MANUAL

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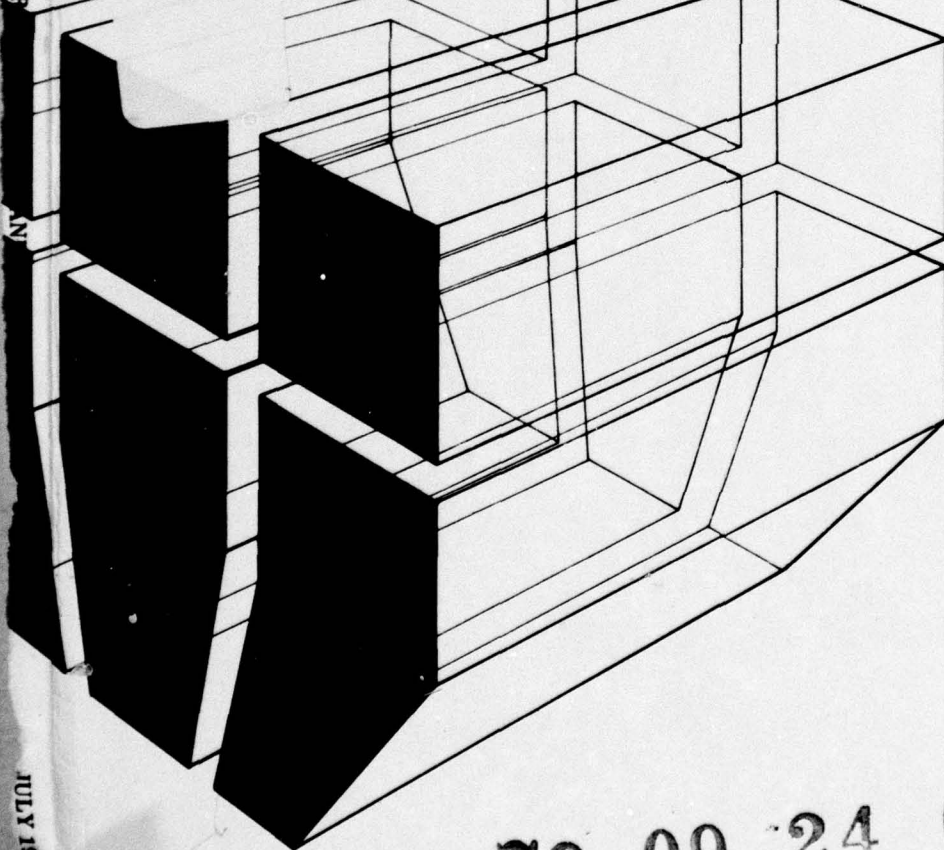
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DEVELOPMENT OF PCI PROCEDURE FOR PAVEMENT

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) Volume I describes the development and verification of a pavement condition index (PCI) for rating jointed concrete (plain and reinforced) and asphalt surfaced roads, streets, parking lots, and hardstands subjected to pneumatic tired and tracked vehicular traffic. A similar method for air fields has been developed and officially adopted by the U.S. Air Force. The PCI, which measures pavement structural integrity and surface operational condition, is calculated based on measured pavement distress types, severities,		



Block 20 continued.

and densities obtained during pavement inspection. Volume II describes the distress types and severity levels, and the measurement criteria to use when collecting data for the PCI calculation.

Field tests indicate that the PCI closely agrees with the collective judgment (mean rating) of experienced pavement engineers. The PCI was found to be much more consistent than ratings by individual engineers since it is based on measured distress data, and not on subjective judgment.

\*Mohamed Y. Shahin, Michael I. Darter, and Starr D. Kohn, *Development of a Pavement Maintenance Management System, Volumes I through V*, AFCEC-TR-76-22 and CEEDO-TR-77-44 (Air Force Civil Engineering Center, November 1976 and October 1977).

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## FOREWORD

This research was conducted for the Directorate of Military Programs with Operation and Maintenance, Army (O&MA) funds under WESMIS No. RA-9 by the Engineering and Materials (EM) Division of the U.S. Army Construction Engineering Research Laboratory (CERL). Dr. Mohamed Shahin was the CERL Principal Investigator. The Technical Monitor was Mr. Leo Price, DAEN-MPO. Dr. G. R. Williamson is Chief of CERL-EM.

Dr. Michael I. Darter is acknowledged for his help in developing the initial PCI procedure. The assistance of the following individuals from the U.S. Army is also acknowledged and appreciated: Mr. Don Engelking, TRADOC; Messrs. Tom Brown and Jack Armstrong, DFAE Fort Benning; Messrs. B. F. Flaherty and K. G. Baer, DARCOM; Mr. Jack Hinte, TRADOC; Mr. F. R. Bourque, DFAE Fort Eustis; Mr. William Taylor, FORSCOM; and Messrs. W. Ament, J. Syers, and B. Garnet, DFAE Fort Hood.

COL J.E. Hays is Commander and Director of CERL and Dr. L.R. Shaffer is Technical Director.

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# DEVELOPMENT OF A PAVEMENT CONDITION RATING PROCEDURE FOR ROADS, STREETS, AND PARKING LOTS VOLUME II: DISTRESS IDENTIFICATION MANUAL

## 1 INTRODUCTION

### Background

In an effort to make the best use of money spent on the maintenance and repair (M&R) of Army pavements, the U.S. Army Construction Engineering Research Laboratory (CERL) has developed a maintenance management system. A major component of this system is the Pavement Condition Index (PCI).

A PCI (Figure 1) reflects the structural integrity, surface operational condition, and M&R requirements of pavement, and is, therefore, an excellent tool for establishing M&R priorities. To obtain consistent and meaningful PCI values, a standard reference must be used to identify and measure the type, severity, and amount of distress in a pavement section (the basis of the PCI calculation), as described in Volume I. The distress descriptions in this volume were developed from field condition surveys, and from experience gained during the development of a similar PCI procedure for airfield pavements.<sup>1</sup>

### Objective

This volume gives pavement inspectors a standard reference for identifying and measuring pavement distress in roads, streets, parking lots, storage areas, and hardstands.

### User Instructions

Types of distress found in asphalt and jointed concrete pavements are listed alphabetically in Chapters 2 and 3, respectively. Each listing includes the name of the distress, its description, a narrative and photographic description of its severity levels, and its standard measurement or count criteria. Nineteen distress types have been identified for each of the jointed

concrete- and asphalt-surfaced pavements; however, only some of these distress types will be frequently encountered during the inspection. Common distress types for asphalt-surfaced pavements include alligator cracking, block cracking, bumps, joint reflection cracking, longitudinal and transverse cracking, patching, potholes, rutting, and weathering. Common distress types for jointed concrete pavements include corner break, divided slab, joint seal damage, linear cracking, patching (over 5 sq ft (.5 m<sup>2</sup>), scaling, shrinkage cracks, corner spalling, and joint spalling. The rest of the distress types included in this manual may not be encountered as frequently except in specific geographic locations. For example, durability ("D") cracking in concrete pavements may be encountered frequently in pavements subjected to a high number of freeze-thaw cycles.

It is important that the pavement inspector be thoroughly familiar with all common distress types and their levels of severity. When determining the PCI for a pavement section, it is imperative that the inspector follow the definitions and criteria described in this report. The inspector should study this report before an inspection and carry a copy for reference during the inspection. Detailed inspection procedure and field data sheets are presented in Volume 1.

### Mode of Technology Transfer

The PCI pavement maintenance management system will be published as an Army Technical Manual and incorporated into the PAVER computer system for Army installations.

## 2 DISTRESS IN ASPHALT PAVEMENTS

During the field condition surveys and validation of the PCI, several questions were commonly asked regarding the identification and measurement of some of the distresses. The answers to these questions are included under the section titled "How to Measure" for each distress. For convenience, however, items that are frequently referenced are listed below:

1. If alligator cracking and rutting occur in the same area, each is recorded separately at its respective severity level.

2. If bleeding is counted, polished aggregate is not counted in the same area.

<sup>1</sup>Mohamed Y. Shahin, Michael I. Darter, and Starr D. Kohn, *Development of a Pavement Maintenance Management System, Volume V, Proposed Revision of Chapter 3, AFR 93-5, CEEDO-TR-77-44* (Civil and Environmental Development Office, Air Force Systems Command, Tyndall Air Force Base, October 1977).



3. Bumps and sags are measured in units of linear feet.

4. If a crack occurs at the ridge or edge of a bump, the crack and bump are recorded separately.

5. If any distress (including cracking and potholes) is found in a patched area, it is not recorded; its affect on the patch, however, is considered in determining the severity level of the patch.

6. A significant amount of polished aggregate should be present before it is counted.

7. Potholes are measured by the number of holes having a certain diameter, not in units of square feet.

The above is not intended to be a complete list. To properly measure each distress type, the inspector must be familiar with its individual measurement criteria.

Nineteen distress types for asphalt-surfaced pavement are listed alphabetically on pages 13 through 63.

#### **Ride Quality**

Ride quality must be evaluated in order to establish a severity level for the following distress types:

1. Bumps

2. Corrugation

3. Railroad crossings

4. Shoving

5. Swells

To determine the effects these distresses have on ride quality, the inspector should use the following severity-level definitions of ride quality:

**L (Low)** – (1) Vehicle vibrations (e.g., from corrugation) are noticeable, but no reduction in speed is necessary for comfort or safety, and/or (2) individual bumps or settlements cause the vehicle to bounce slightly, but create little discomfort.

**M (Medium)** – (1) Vehicle vibrations are significant and some reduction in speed is necessary for safety and comfort, and/or (2) individual bumps or settlements cause the vehicle to bounce significantly, creating some discomfort.

**H (High)** – (1) Vehicle vibrations are so excessive that speed must be reduced considerably for safety and comfort, and/or (2) individual bumps or settlements cause the vehicle to bounce excessively, creating substantial discomfort, and/or a safety hazard, and/or high potential vehicle damage.

Ride quality is determined by riding in a standard-size automobile over the pavement section at the posted speed limit. Pavement sections near stop signs should be rated at the normal deceleration speed used when approaching the sign.

## ALPHABETICAL LISTING OF DISTRESS TYPES

**Name of Distress:** Alligator Cracking

**Description:**

Alligator or fatigue cracking is a series of interconnecting cracks caused by fatigue failure of the asphalt concrete surface under repeated traffic loading. Cracking begins at the bottom of the asphalt surface (or stabilized base) where tensile stress and strain are highest under a wheel load. The cracks propagate to the surface initially as a series of parallel longitudinal cracks. After repeated traffic loading, the cracks connect, forming many-sided, sharp-angled pieces that develop a pattern resembling chicken wire or the skin of an alligator. The pieces are less than 2 ft (.6 m) on the longest side.

Alligator cracking occurs only in areas subjected to repeated traffic loading, such as wheel paths. Therefore, it would not occur over an entire area unless the entire area were subjected to traffic loading. (Pattern-type cracking which occurs over an entire area that is not subjected to loading is called block cracking, which is not a load-associated distress.)

Alligator cracking is considered a major structural distress and is usually accompanied by rutting.

**Severity Levels:**

- L — Fine, longitudinal hairline cracks running parallel to each other with none or only a few interconnecting cracks. The cracks are not spalled.\* (Figures 2 and 3)
- M — Further development of light alligator cracks into a pattern or network of cracks that may be lightly spalled. (Figures 4, 5, and 6)
- H — Network or pattern cracking has progressed so that the pieces are well defined and spalled at the edges. Some of the pieces may rock under traffic. (Figures 7 and 8)

**How to Measure:**

Alligator cracking is measured in square feet of surface area. The major difficulty in measuring this type of distress is that two or three levels of severity often exist within one distressed area. If these portions can be easily distinguished from each other, they should be measured and recorded separately. However, if the different levels of severity cannot be divided easily, the entire area should be rated at the highest severity level present.

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\*Crack spalling is a breakdown of the material along the sides of the crack.



# ALPHABETICAL LISTING OF DISTRESS TYPES

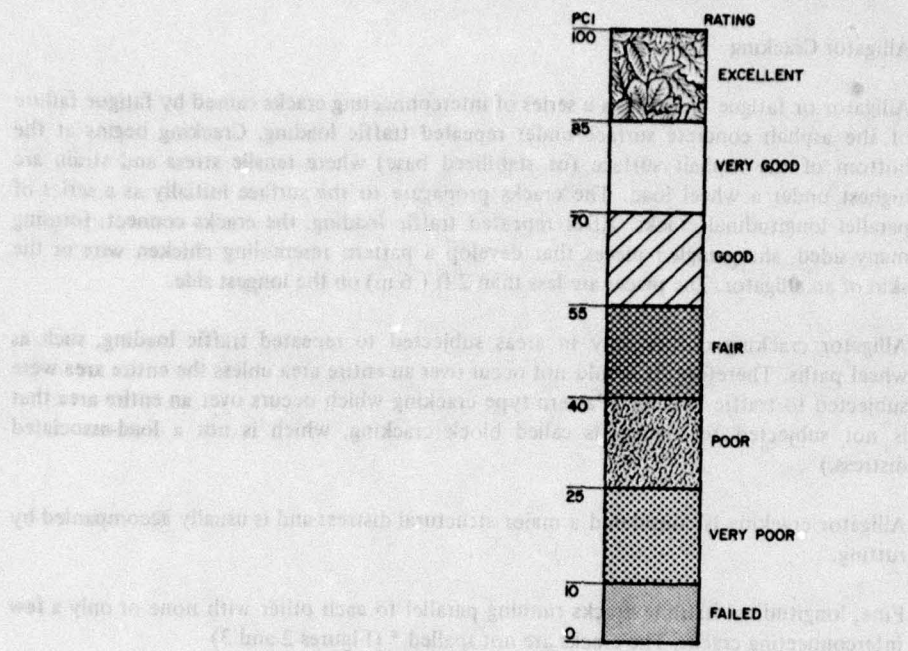


Figure 1. Pavement Condition Index.

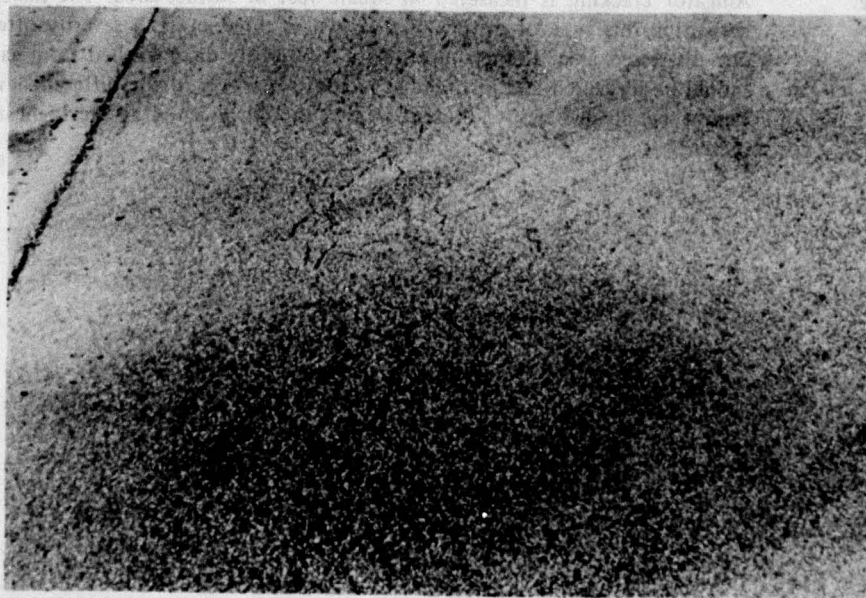
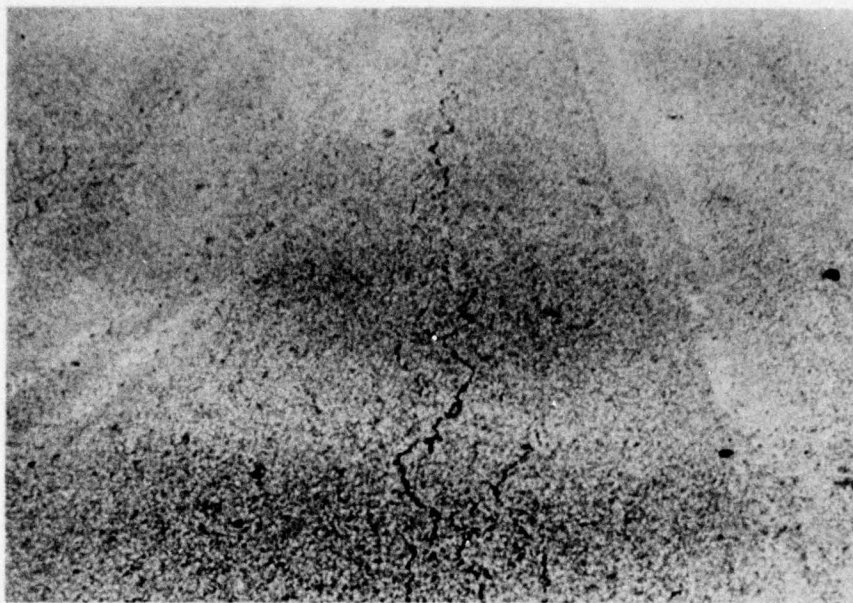


Figure 2. Low-severity alligator cracking.



**Figure 3.** Low-severity alligator cracking.



**Figure 4.** Medium-severity alligator cracking.





**Figure 5.** Medium-severity alligator cracking.



**Figure 6.** Medium-severity alligator cracking.



Figure 7. High-severity alligator cracking.

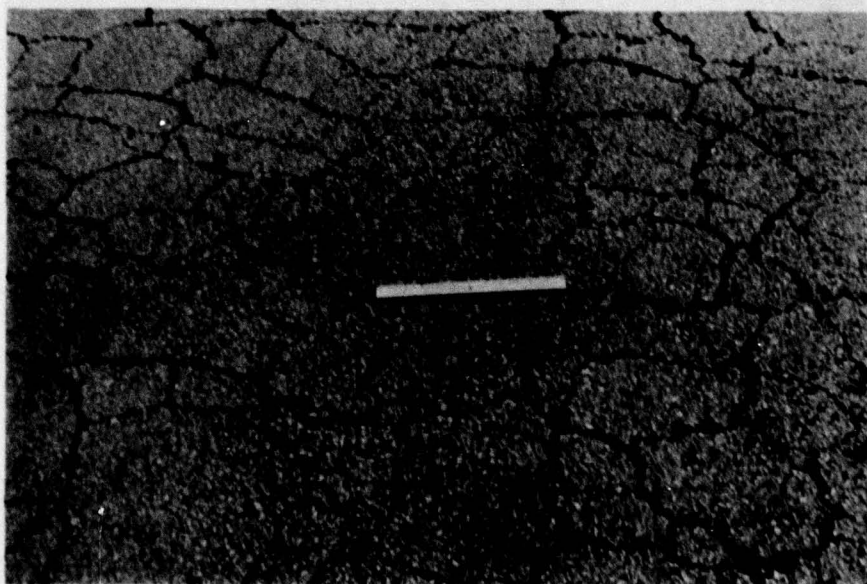


Figure 8. High-severity alligator cracking.



**Name of Distress:** Bleeding

**Description:** Bleeding is a film of bituminous material on the pavement surface which creates a shiny, glasslike, reflecting surface that usually becomes quite sticky. Bleeding is caused by excessive asphalt cement or tars in the mix, excess application of a bituminous sealant, and/or low air void content. It occurs when asphalt fills the voids of the mix during hot weather and then expands onto the pavement surface. Since the bleeding process is not reversible during cold weather, asphalt or tar will accumulate on the surface.

**Severity Levels:** L — Bleeding has only occurred to a very slight degree and it is noticeable only during a few days of the year. Asphalt does not stick to shoes or vehicles. (Figure 9)

M — Bleeding has occurred to the extent that asphalt sticks to shoes and vehicles during only a few weeks of the year. (Figure 10)

H — Bleeding has occurred extensively and considerable asphalt sticks to shoes and vehicles during at least several weeks of the year. (Figure 11)

**How to Measure:** Bleeding is measured in square feet of surface area.

If bleeding is counted, polished aggregate should not be counted.



**Figure 9.** Low-severity bleeding.



**Figure 10.** Medium-severity bleeding.



**Figure 11.** High-severity bleeding.



**Name of Distress:** Block Cracking

**Description:** Block cracks are interconnected cracks that divide the pavement into approximately rectangular pieces. The blocks may range in size from approximately 1 by 1 ft (.3 by .3 m) to 10 by 10 ft (3 by 3 m). Block cracking is caused mainly by shrinkage of the asphalt concrete and daily temperature cycling (which results in daily stress/strain cycling). It is not load-associated. Block cracking usually indicates that the asphalt has hardened significantly. Block cracking normally occurs over a large proportion of pavement area, but sometimes will occur only in nontraffic areas. This type of distress differs from alligator cracking in that alligator cracks form smaller, many-sided pieces with sharp angles. Also, unlike block cracks, alligator cracks are caused by repeated traffic loadings, and are therefore found only in traffic areas (i.e., wheel paths).

**Severity Levels:** L – Blocks are defined by low\* severity cracks. (Figure 12)

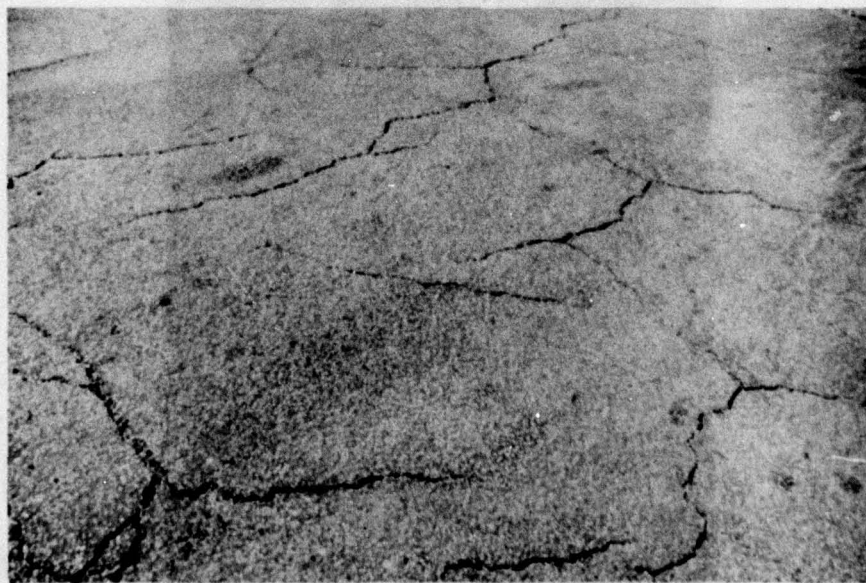
M – Blocks are defined by medium\* severity cracks. (Figures 13 and 14)

H – Blocks are defined by high\* severity cracks. (Figure 15)

**How to Measure:** Block cracking is measured in square feet of surface area. It usually occurs at one severity level in a given pattern section; however, any areas of the pavement section having distinctly different levels of severity should be measured and recorded separately.

---

\*See definition of longitudinal and transverse cracking, p 40.



**Figure 12.** Low-severity block cracking.



**Figure 13.** Medium-severity block cracking.



**Figure 14.** Medium-severity block cracking.





**Figure 15.** High-severity block cracking (a few inches around the crack are severely broken).

**Name of Distress:** Bumps and Sags

**Description:** Bumps are small, localized, upward displacements of the pavement surface. They are different from shoves in that shoves are caused by unstable pavement. Bumps, on the other hand, can be caused by several factors, including:

1. Buckling or bulging of underlying portland cement concrete (PCC) slabs in asphalt concrete [AC] overlayover PCC pavement.
2. Frost heave (ice, lens growth).
3. Infiltration and buildup of material in a crack in combination with traffic loading (sometimes called tenting).

Sags are small, abrupt, downward displacements of the pavement surface.

Distortion and displacement which occurs over large areas of the pavement surface, causing large and/or long dips in the pavement is called swelling (see p 60).

**Severity Levels:** L – Bump or sag causes low-severity ride quality. (Figure 16)

M – Bump or sag causes medium-severity ride quality. (Figures 17, 18, and 19)

H – Bump or sag causes high-severity ride quality. (Figure 20)

**How to Measure:** Bumps or sags are measured in linear feet. If bumps appear in a pattern perpendicular to traffic flow and are spaced at less than 10 ft (3 m), the distress is called corrugation. If the bump occurs in combination with a crack, the crack is also recorded.

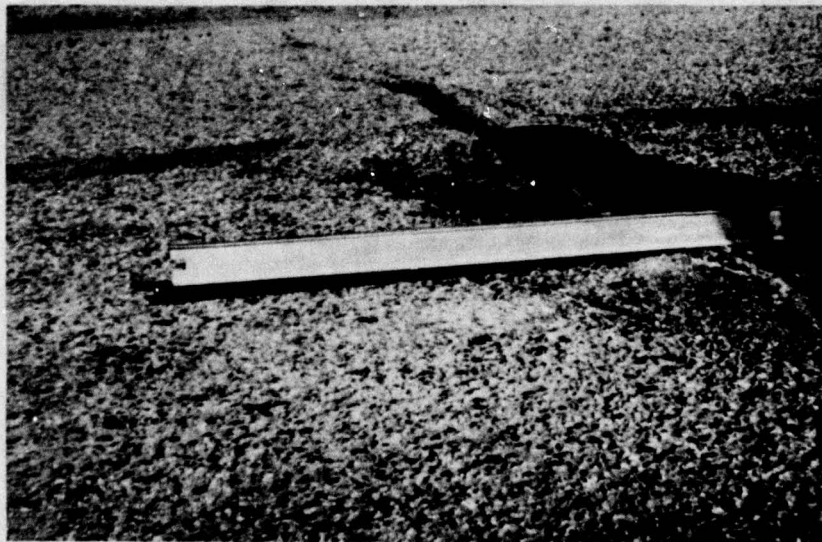
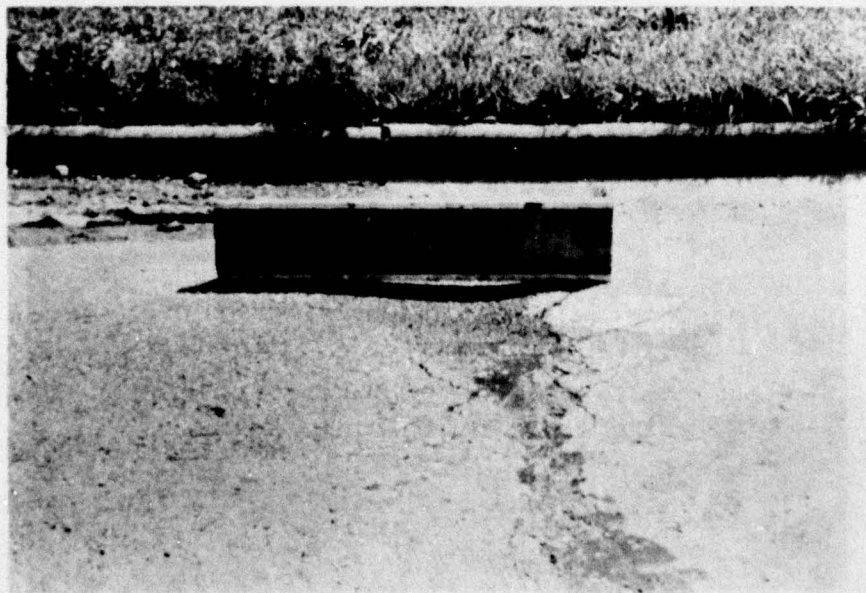


Figure 16. Low-severity bumps and sags.

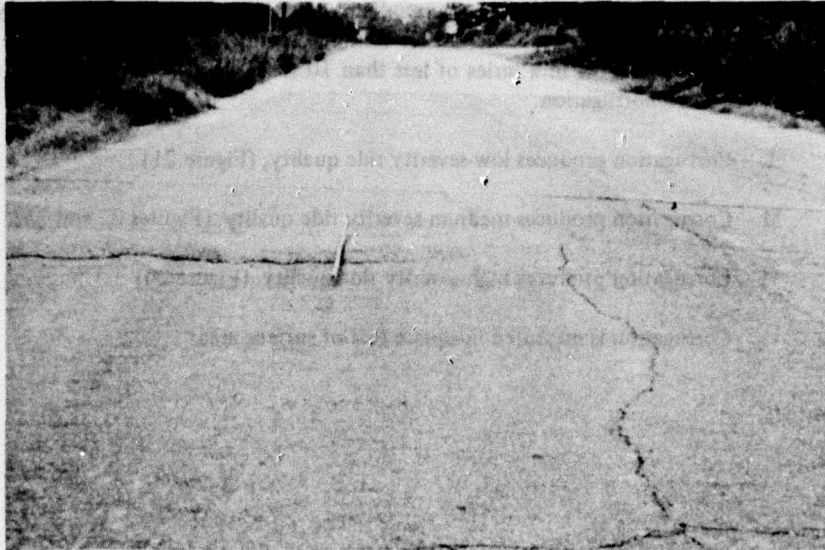




**Figure 17.** Medium-severity bumps and sags.



**Figure 18.** Medium-severity bumps and sags.



**Figure 19.** Medium-severity bumps and sags.



**Figure 20.** High-severity bumps and sags.



**Name of Distress:** Corrugation

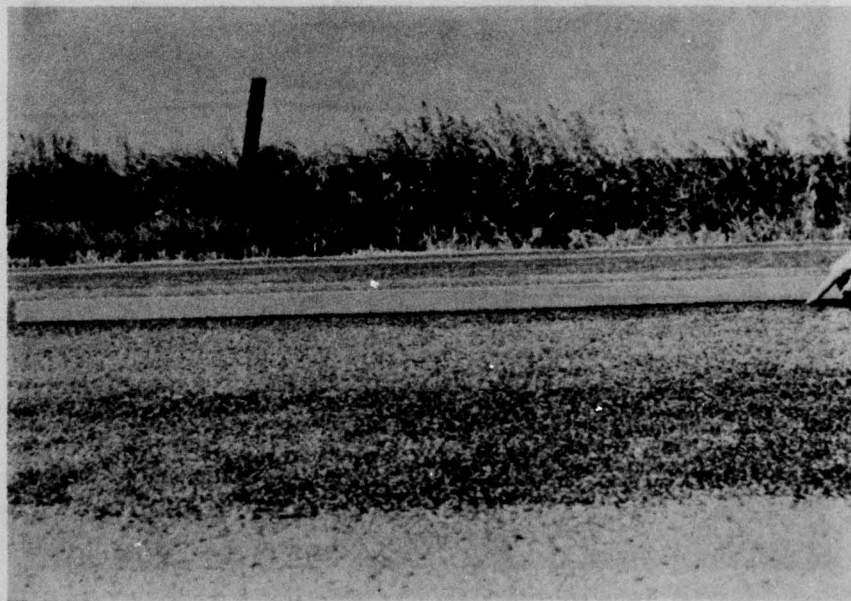
**Description:** Corrugation (also known as washboarding) is a series of closely spaced ridges and valleys (ripples) occurring at fairly regular intervals—usually less than 10 ft (3 m) along the pavement. The ridges are perpendicular to the traffic direction. This type of distress is usually caused by traffic action combined with an unstable pavement surface or base. If bumps occur in a series of less than 10 ft (3 m), due to any cause, the distress is considered corrugation.

**Severity Levels:** L — Corrugation produces low-severity ride quality. (Figure 21)

M — Corrugation produces medium-severity ride quality. (Figures 22 and 23)

H — Corrugation produces high-severity ride quality. (Figure 24)

**How to Measure:** Corrugation is measured in square feet of surface area.



**Figure 21.** Low-severity corrugation.

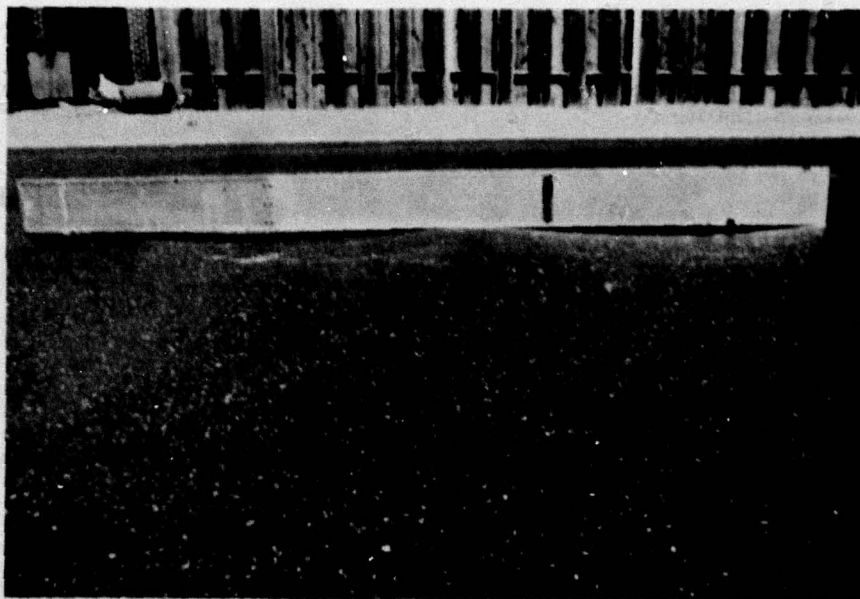
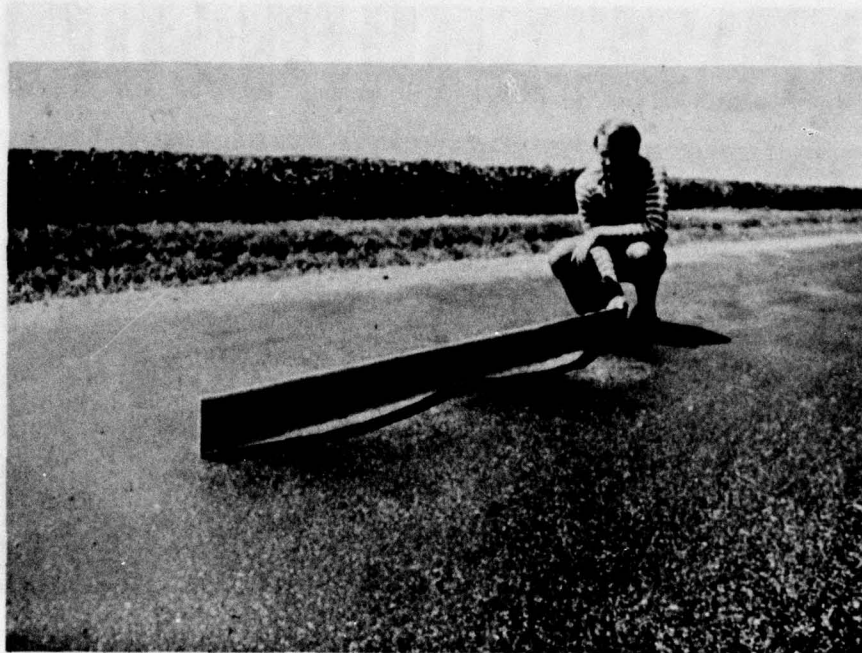


Figure 22. Medium-severity corrugation.



Figure 23. Medium-severity corrugation.





**Figure 24.** High-severity corrugation.



**Name of Distress:** Depression

**Description:** Localized pavement surface areas with elevations slightly lower than those of the surrounding pavement are called depressions. In many instances, light depressions are not noticeable until after a rain, when ponding water creates "birdbath" areas; on dry pavement, depressions can be spotted by looking for stains caused by ponding water. Depressions are created by settlement of the foundation soil or are a result of improper construction. Depressions cause some roughness, and when filled with water of sufficient depth, can cause hydroplaning.

Sags, unlike depressions, are abrupt drops in elevations (see p 23).

**Severity Levels:** Maximum Depth of Depression

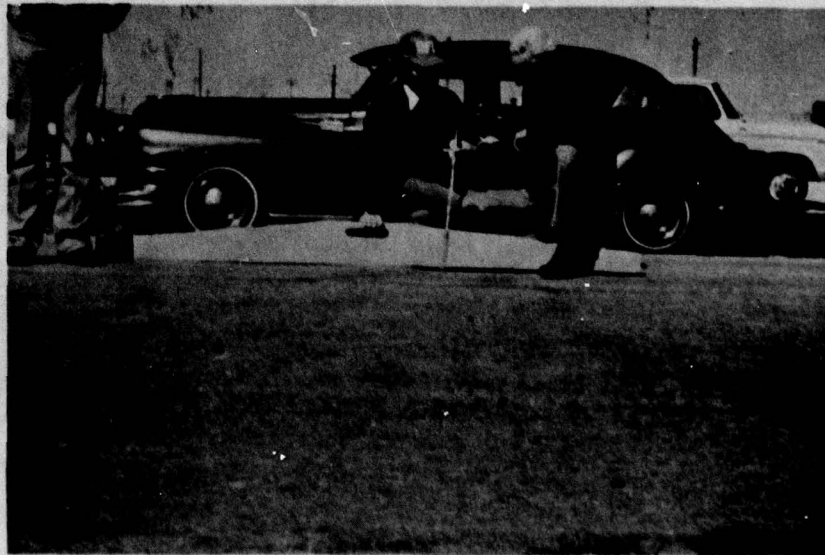
L – 1/2 to 1 in. (13 to 25 mm)

M – 1 to 2 in. (25 to 51 mm)

H – more than 2 in. (51 mm)

See Figures 25 through 27.

**How to Measure:** Depressions are measured in square feet of surface area.



**Figure 25.** Low-severity depression.



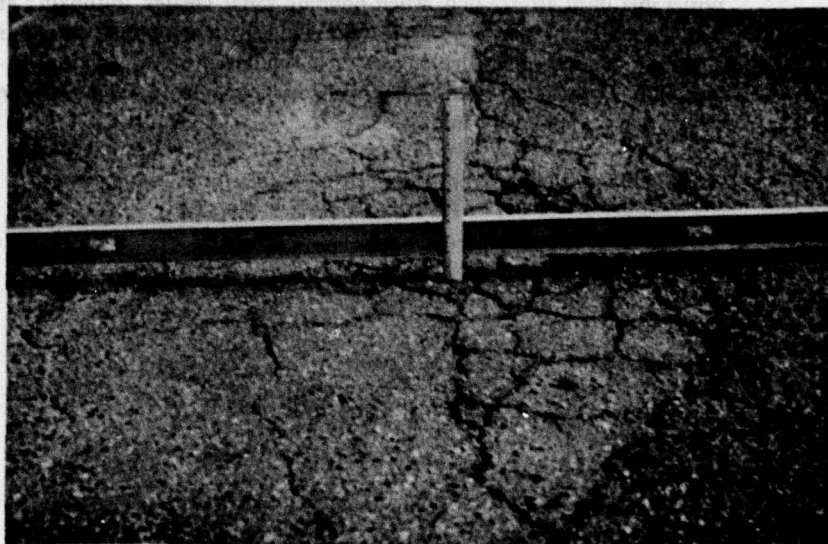


Figure 26. Medium-severity depression.

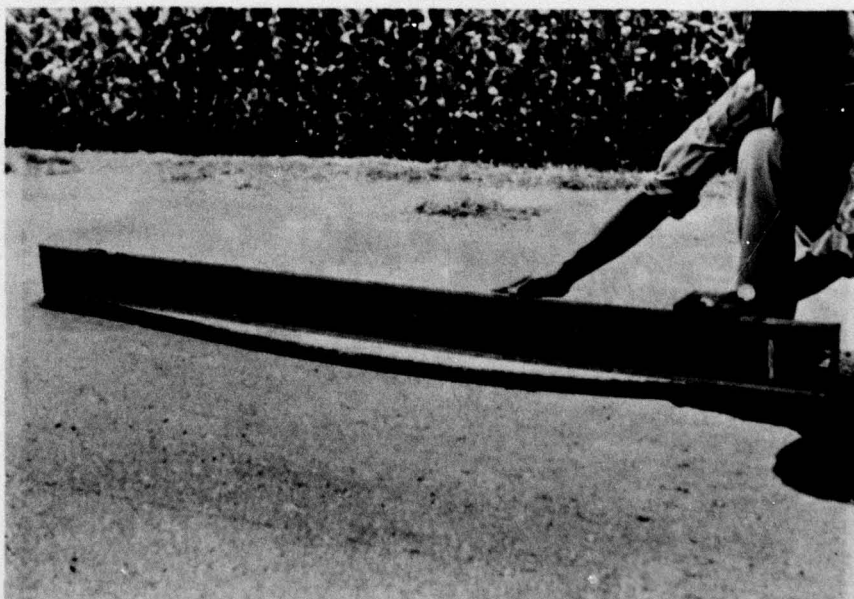


Figure 27. High-severity depression.

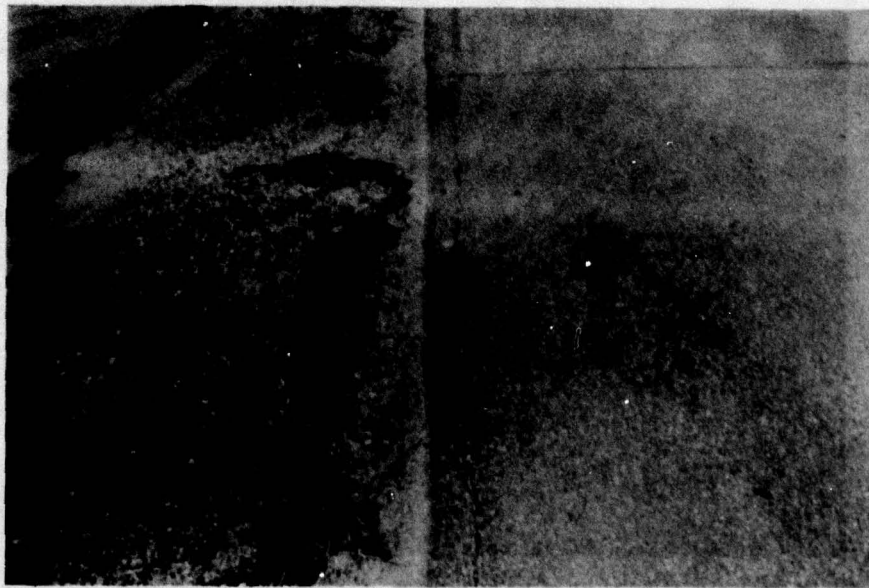
**Name of Distress:** Edge Cracking

**Description:** Edge cracks are parallel to and usually within 1 to 2 ft (.3 to .6 m) of the outer edge of the pavement. This distress is accelerated by traffic loading and can be caused by frost-weakened base or subgrade near the edge of the pavement. The area between the crack and pavement edge is classified as raveled if it breaks up (sometimes to the extent that pieces are removed).

**Severity Levels:**

- L – Low or medium cracking with no breakup or raveling. (Figure 28)
- M – Medium cracks with some breakup and raveling. (Figure 29)
- H – Considerable breakup or raveling along the edge. (Figures 30 and 31)

**How to Measure:** Edge cracking is measured in linear feet.



**Figure 28.** Low-severity edge cracking.



The cracks are parallel to and usually within 1 to 3 ft (0.3 to 0.9 m) of the outer edge of the pavement. This distress is characterized by traffic loading and can be caused by frost action between the crack and the pavement that



**Figure 29.** Medium-severity edge cracking.



**Figure 30.** High-severity edge cracking.



**Figure 31.** High-severity edge cracking.



**Name of Distress:** Joint Reflection Cracking (from Longitudinal and Transverse PCC Slabs)

**Description:** This distress occurs only on asphalt-surfaced pavements which have been laid over a PCC slab. It does not include reflection cracks from any other type of base (i.e., cement- or lime-stabilized); such cracks are listed as longitudinal cracks and transverse cracks. Joint reflection cracks are mainly caused by the thermal- or moisture-induced movement of the PCC slab beneath the AC surface. This distress is not load-related; however, traffic loading may cause a breakdown of the AC surface near the crack. If the pavement is fragmented along a crack, the crack is said to be spalled. A knowledge of slab dimensions beneath the AC surface will help to identify these distresses.

**Severity Levels:** L – One of the following conditions exist (Figure 32):

1. Nonfilled crack width is less than 3/8 in. (10 mm), or
2. Filled crack of any width (filler in satisfactory condition).

M – One of the following conditions exist (Figure 33):

1. Nonfilled crack width is 3/8 to 3 in. (10 to 76 mm).
2. Nonfilled crack of any width up to 3 in. (76 mm) surrounded by light random cracking. (Figure 33)
3. Filled crack of any width surrounded by light random cracking.

H – One of the following conditions exist (Figure 34):

1. Any crack filled or nonfilled surrounded by medium or high severity random cracking.
2. Nonfilled cracks over 3 in. (76 mm).
3. A crack of any width where a few inches of pavement around a crack is severely broken. (Crack is severely broken.)

**How to Measure:** Joint reflection cracking is measured in linear feet. The length and severity level of each crack should be recorded separately. For example, a crack that is 50 ft (15 m) long may have 10 ft (3 m) of high severity; these would all be recorded separately. If a bump occurs at the reflection crack, it is also recorded.



Figure 32. Low-severity joint reflection cracking.



Figure 33. Medium-severity joint reflection cracking.





**Figure 34.** High-severity joint reflection cracking.

**Name of Distress:** Lane/Shoulder Drop Off

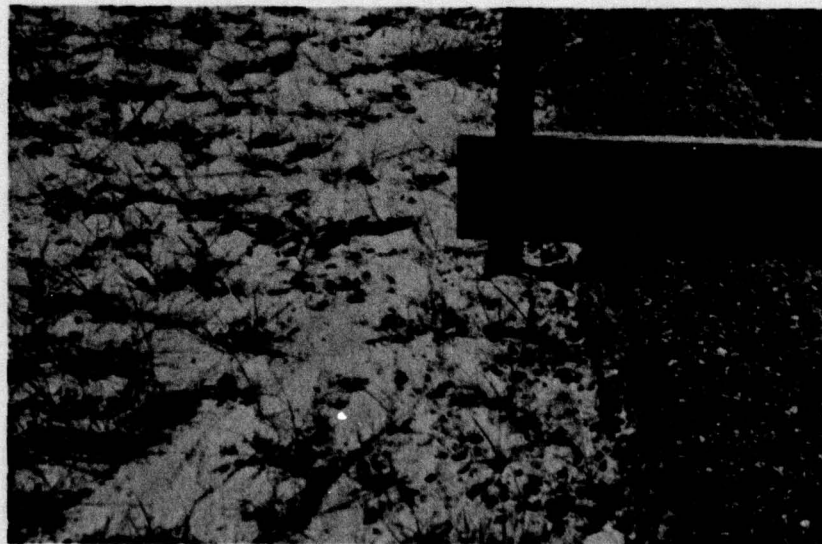
**Description:** Lane/shoulder drop off is a difference in elevation between the pavement edge and the shoulder. This distress is caused by shoulder erosion, shoulder settlement, or by building up the roadway without adjusting the shoulder level.

**Severity Levels:** L – The difference in elevation between the pavement edge and shoulder is 1 to 2 in. (25 to 51 mm). (Figure 35)

M – The difference in elevation is over 2 to 4 in. (51 to 102 mm). (Figure 36)

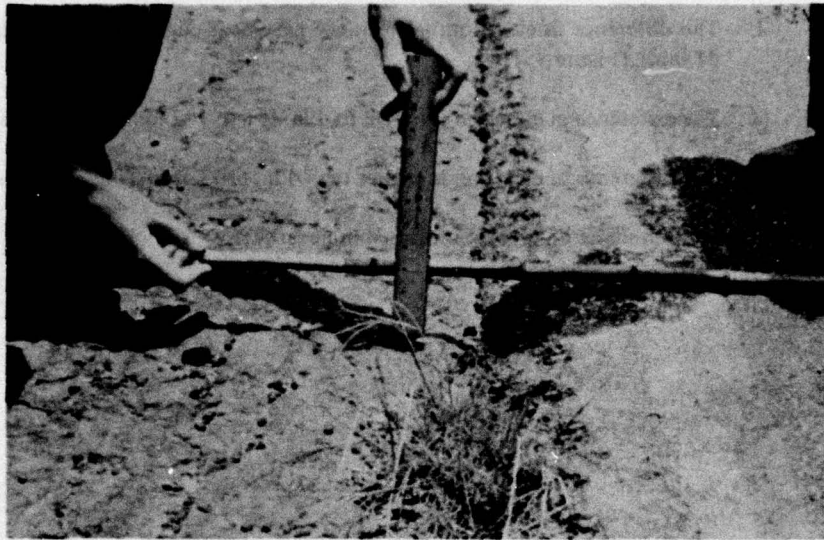
H – The difference in elevation is greater than 4 in. (102 mm). (Figures 37 and 38)

**How to Measure:** Lane/shoulder drop off is measured in linear feet.

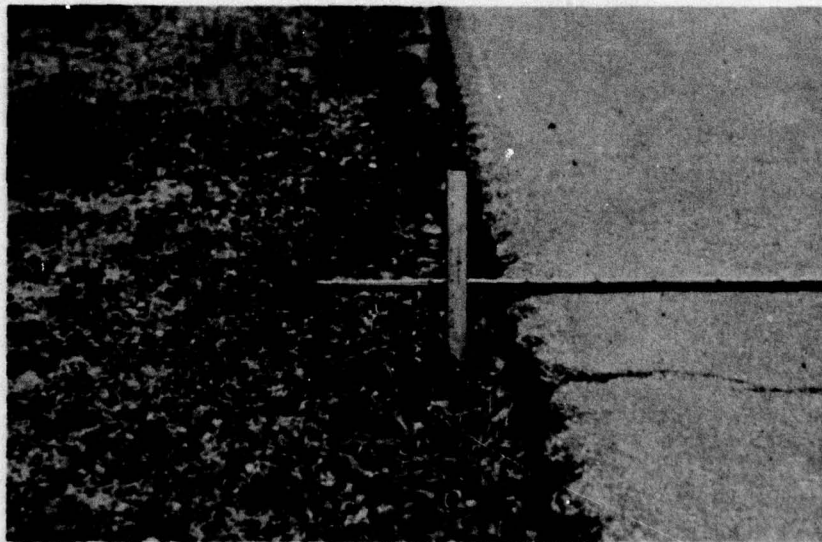


**Figure 35.** Low-severity lane/shoulder drop off.





**Figure 36.** Medium-severity lane/shoulder drop off.



**Figure 37.** High-severity lane/shoulder drop off.



**Figure 38. High-severity lane/shoulder drop off.**



**Name of Distress:** Longitudinal and Transverse Cracking (Non-PCC Slab Joint Reflective)

**Description:** Longitudinal cracks are parallel to the pavement's centerline or laydown direction. They may be caused by:

1. A poorly constructed paving lane joint.
2. Shrinkage of the AC surface due to low temperatures or hardening of the asphalt and/or daily temperature cycling.
3. A reflective crack caused by cracking beneath the surface course, including cracks in PCC slabs (but not PCC joints).

Transverse cracks extend across the pavement at approximately right angles to the pavement centerline or direction of laydown. These may be caused by conditions (2) and (3) above. These types of cracks are not usually load-associated.

**Severity Levels:** L – One of the following conditions exist (see Figure 39):

1. Nonfilled crack width is less than 3/8 in. (10 mm), or
2. Filled crack of any width (filler in satisfactory condition).

M – One of the following conditions exist (Figures 40 and 41):

1. Nonfilled crack width is 3/8 to 3 in. (10 to 76 mm).
2. Nonfilled crack of any width up to 3 in. (76 mm) surrounded by light and random cracking.
3. Filled crack of any width surrounded by light random cracking.

H – One of the following conditions exist (Figure 42):

1. Any crack filled or nonfilled surrounded by medium or high severity random cracking.
2. Nonfilled crack over 3 in. (76 mm).
3. A crack of any width where a few inches of pavement around the crack is severely broken.

**How to Measure:**

Longitudinal and transverse cracks are measured in linear feet. The length and severity of each crack should be recorded after identification. If the crack does not have the same severity level along its entire length, each portion of the crack having a different severity level should be recorded separately. If a bump or sag occurs at the crack, it is also recorded.

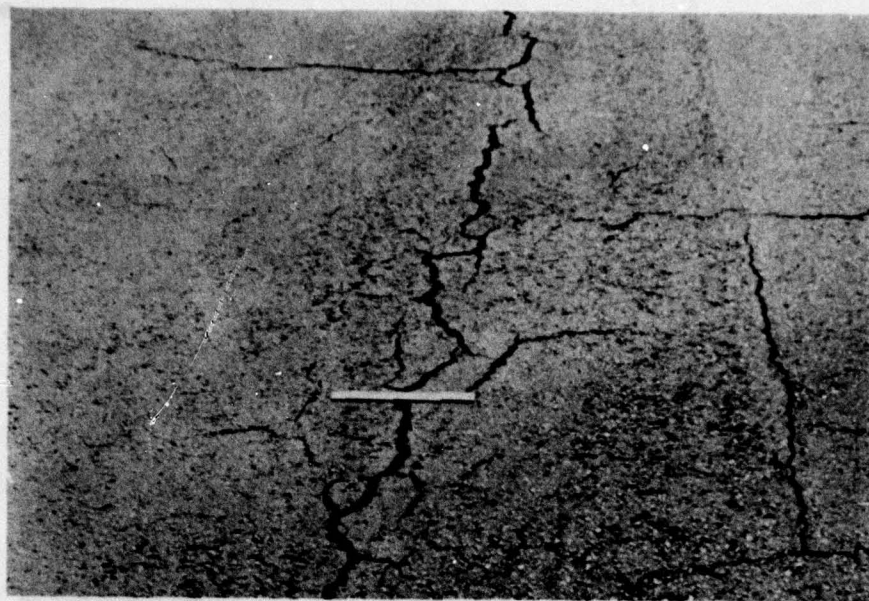


**Figure 39.** Low-severity longitudinal and transverse cracking.



**Figure 40.** Medium-severity longitudinal and transverse cracking.





**Figure 41.** Medium-severity longitudinal and transverse cracking [ $3/4$  in. (19 mm) crack surrounded by light random cracks].



**Figure 42.** High-severity longitudinal and transverse cracking.

**Name of Distress:** Patching and Utility Cut Patching

**Description:** A patch is an area of pavement which has been replaced with new material to repair the existing pavement.

A patch is considered a defect no matter how well it is performing (a patched area or adjacent area usually does not perform as well as an original pavement section). Generally, some roughness is associated with this distress.

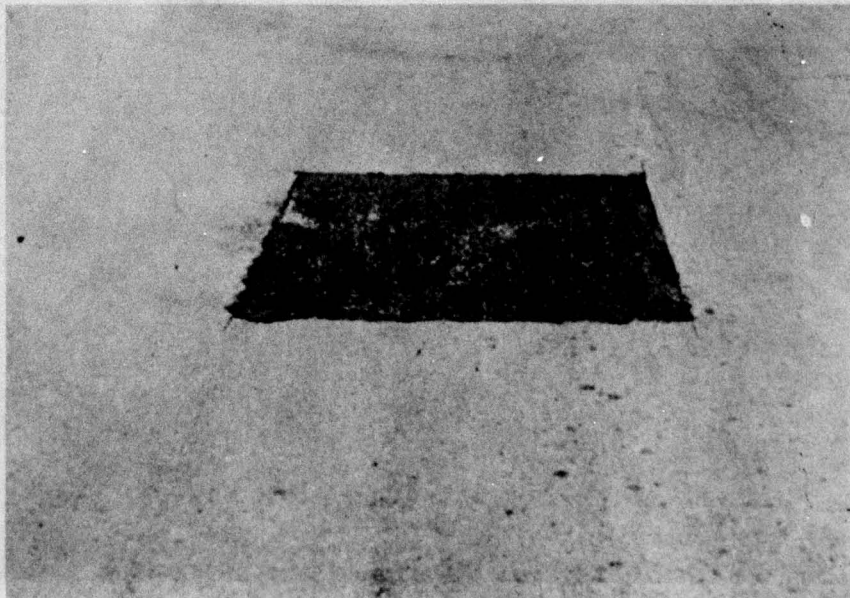
**Severity Levels:** L – Patch is in good condition and satisfactory. Ride quality is rated as low severity or better. (Figures 43, 44, and 45)

M – Patch is moderately deteriorated and/or ride quality is rated as medium severity. (Figure 46)

H – Patch is badly deteriorated and/or ride quality is rated as high severity. Patch needs replacement soon. (Figure 47)

**How to Measure:** Patching is rated in square feet of surface area. However, if a single patch has areas of differing severity, these areas should be measured and recorded separately. For example, a 25-sq-ft (2.32 m<sup>2</sup>) patch may have 10 sq ft (.9 m<sup>2</sup>) of medium severity and 15 sq ft (1.35 m<sup>2</sup>) of low severity. These areas would be recorded separately. No other distresses (e.g., shoving or cracking) are recorded within a patch (e.g., even if patch material is shoving or cracking, the area is rated only as a patch).

If a large amount of pavement has been replaced, it should not be recorded as a patch, but considered as new pavement (e.g., replacement of full intersection).



**Figure 43.** Low-severity patching and utility cut patching.





**Figure 44.** Low-severity patching and utility cut patching.



**Figure 45.** Low-severity patching and utility cut patching.



**Figure 46.** Medium-severity patch.



**Figure 47.** High-severity patching and utility cut patching.

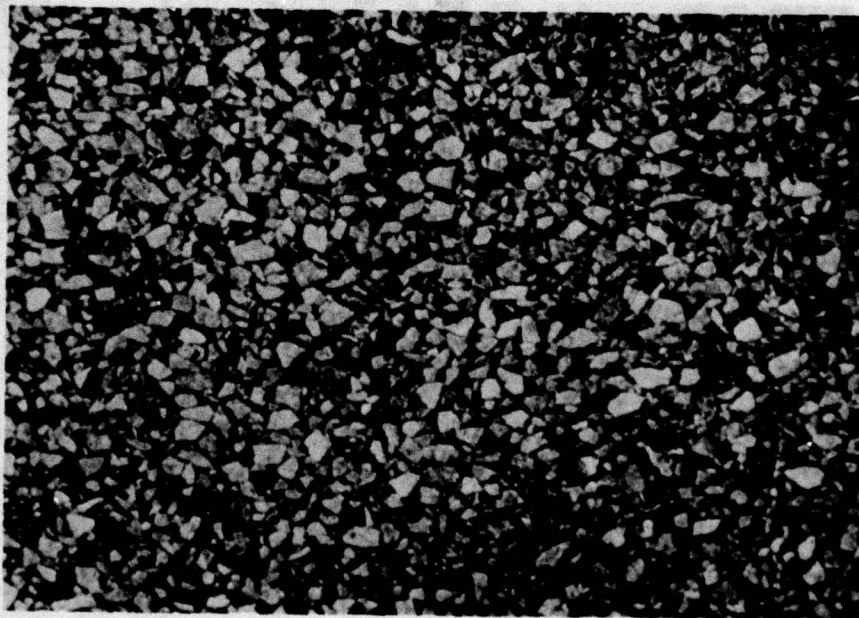


**Name of Distress:** Polished Aggregate

**Description:** This distress is caused by repeated traffic applications. When the aggregate in the surface becomes smooth to the touch, adhesion with vehicle tires is considerably reduced. When the portion of aggregate extending above the surface is small, the pavement texture does not significantly contribute to reducing vehicle speed. Polished aggregate should be counted when close examinations reveals that the aggregate extending above the asphalt is negligible, and the surface aggregate is smooth to the touch. This type of distress is indicated when the number on a skid resistance test is low or has dropped significantly from previous ratings.

**Severity Levels:** No degrees of severity are defined. However, the degree of polishing should be significant before it is included in the condition survey and rated as a defect (Figure 48)

**How to Count:** Polished aggregate is measured in square feet of surface area. If bleeding is counted, polished aggregate should not be counted.



**Figure 48.** Polished aggregate.

**Name of Distress:** Potholes

**Description:** Potholes are small [usually less than 3 ft (.9 m) in diameter], bowl-shaped depressions in the pavement surface. They generally have sharp edges and vertical sides near the top of the hole. Their growth is accelerated by free moisture collection inside the hole. Potholes are produced when traffic abrades small pieces of the pavement surface. The pavement then continues to disintegrate because of poor surface mixtures, weak spots in the base or subgrade, or because it has reached a condition of high-severity alligator cracking. Potholes are generally structurally related distresses and should not be confused with raveling and weathering. Thus, when holes are created by high-severity alligator cracking, they should be identified as potholes, not as weathering.

**Severity Levels:** The levels of severity for potholes under 30 in. (762 mm) in diameter are based on both the diameter and the depth of the pothole according to the following table.

Maximum Depth of Pothole	Average Diameter (in.) (mm)		
	4 to 8 in. (102 to 203 mm)	8 to 18 in. (203 to 457 mm)	18 to 30 in. (457 to 762 mm)
1/2 to 1 in. (1.27 to 2.54 cm)	L	L	M
>1 to 2 in. (2.54 to 5.08 cm)	L	M	H
> 2 in. (5.08 cm)	M	M	H

If the pothole is over 30 in. (76 mm) in diameter, the area should be determined in square feet and divided by 5 sq ft (.47 m<sup>2</sup>) to find the equivalent number of holes. If the depth is 1 in. (25 mm) or less, they are considered medium severity. If the depth is over 1 in. (25 mm), they are considered high severity. (Figures 49 through 53)

**How to Measure:** Potholes are measured by counting the number that are low, medium, and high severity and recording them separately.





Figure 49. Low-severity pothole.

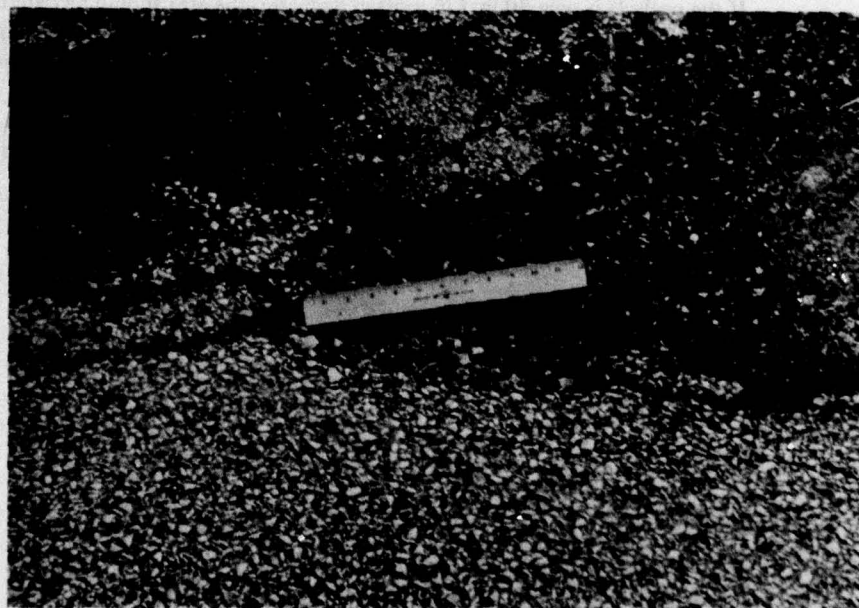


Figure 50. Low-severity pothole.

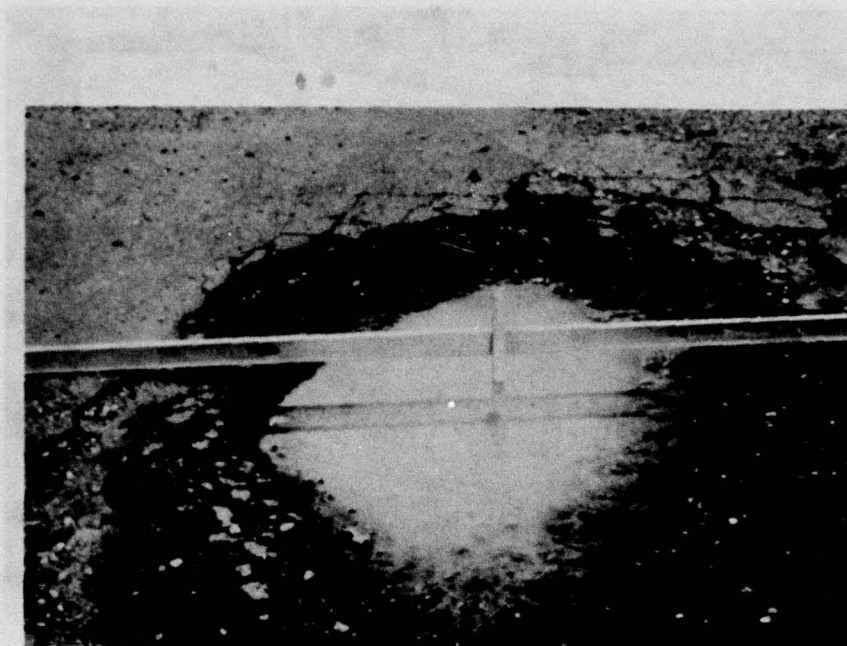


**Figure 51.** Medium-severity pothole.



**Figure 52.** High-severity pothole.





**Figure 53.** High-severity pothole.

**Name of Distress:** Railroad Crossing

**Description:** Railroad crossing defects are depressions or bumps around and/or between tracks.

**Severity Levels:** L – Railroad crossing causes low-severity ride quality. (Figure 54)

M – Railroad crossing causes medium-severity ride quality. (Figure 55)

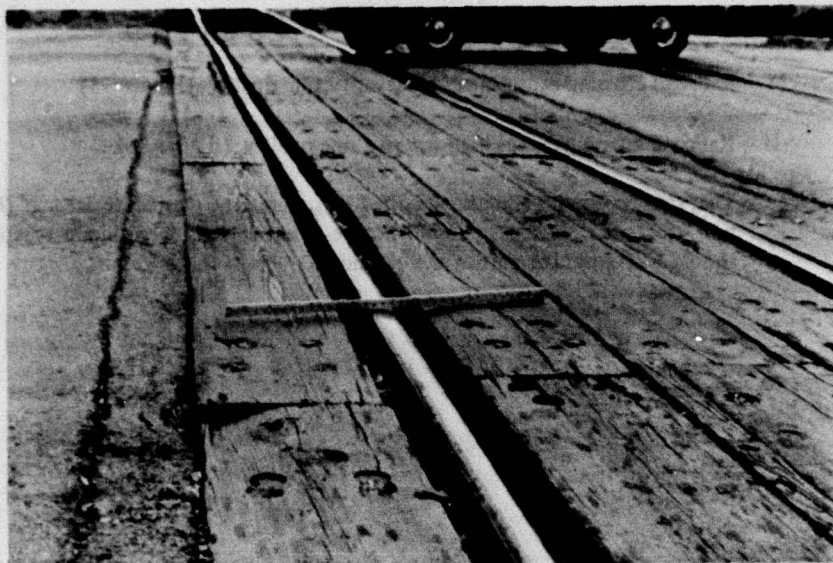
H – Railroad crossing causes high-severity ride quality. (Figure 56)

**How to Measure:** The area of the crossing is measured in square feet of surface area. If the crossing does not affect ride quality, it should not be counted. Any large bump created by the tracks should be counted as part of the crossing.



**Figure 54.** Low-severity railroad crossing.





**Figure 55.** Medium-severity railroad crossing.



**Figure 56.** High-severity railroad crossing.

**Name of Distress:** Rutting

**Description:** A rut is a surface depression in the wheel paths. Pavement uplift may occur along the sides of the rut, but, in many instances, ruts are noticeable only after a rainfall, when the paths are filled with water. Rutting stems from a permanent deformation in any of the pavement layers or subgrade, usually caused by consolidated or lateral movement of the materials due to traffic loads. Significant rutting can lead to major structural failure of the pavement.

**Severity Levels:** *Mean Rut Depth*

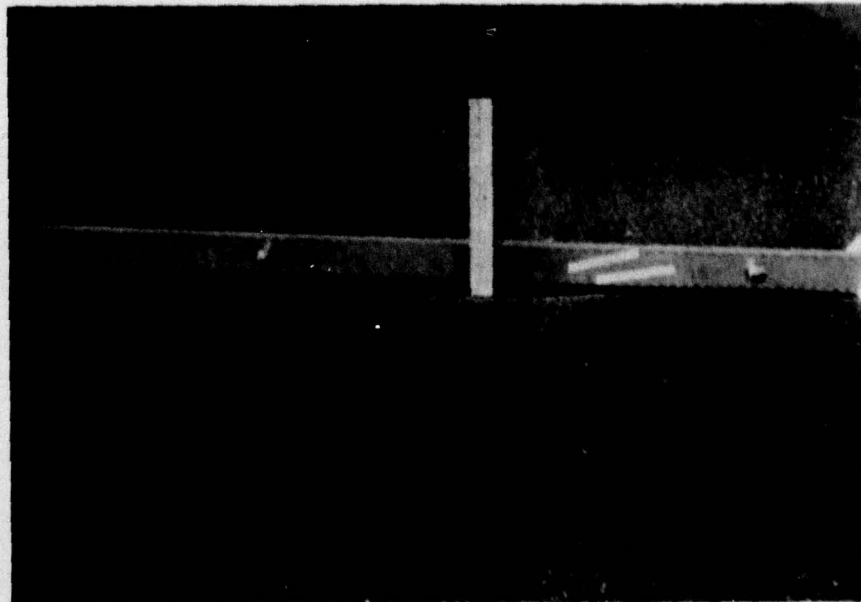
L – 1/4 to 1/2 in. (6 to 13 mm)

M – > 1/2 to 1 in. (> 13 to 25 mm)

H – > 1 in. (> 25 mm)

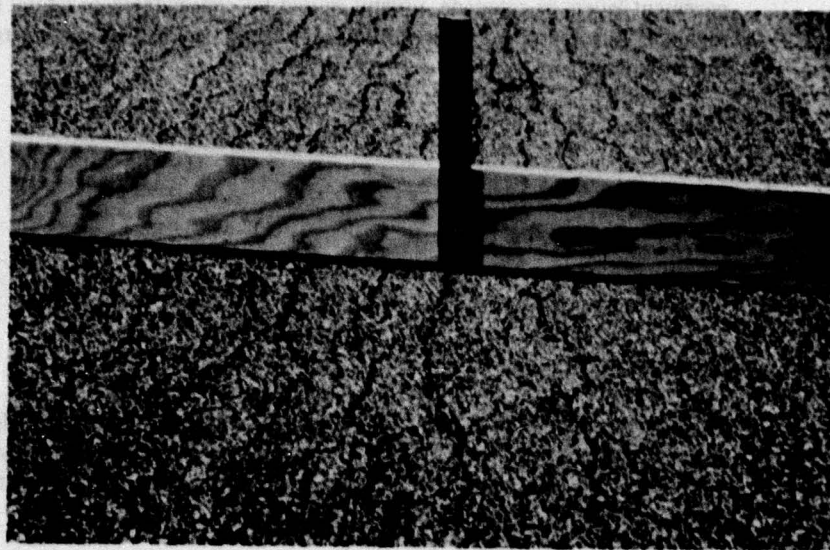
See Figures 57 through 60.

**How to Measure:** Rutting is measured in square feet of surface area, and its severity is determined by the mean depth of the rut (see above). The mean rut depth is calculated by laying a straight-edge across the rut, measuring its depth, then using measurements taken along the length of the rut to compute its mean depth in inches.

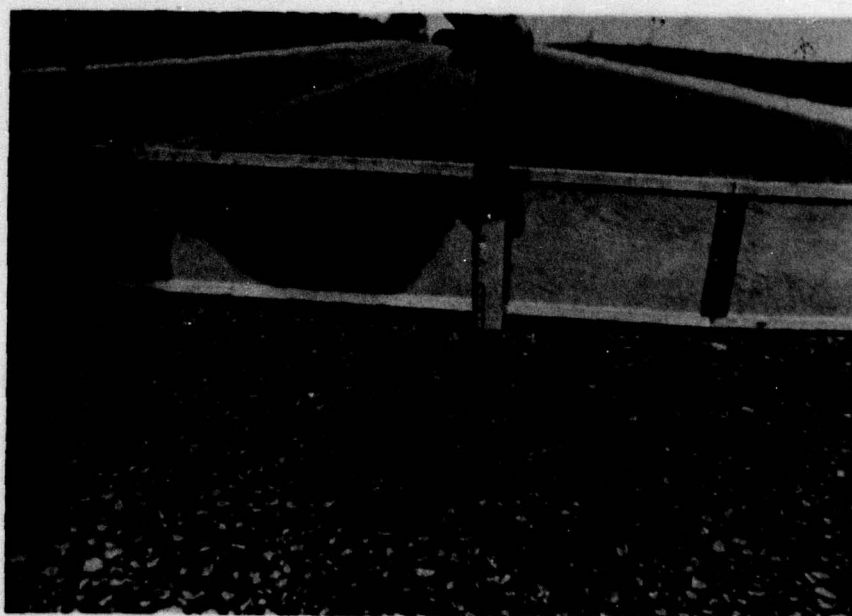


**Figure 57.** Low-severity rutting.

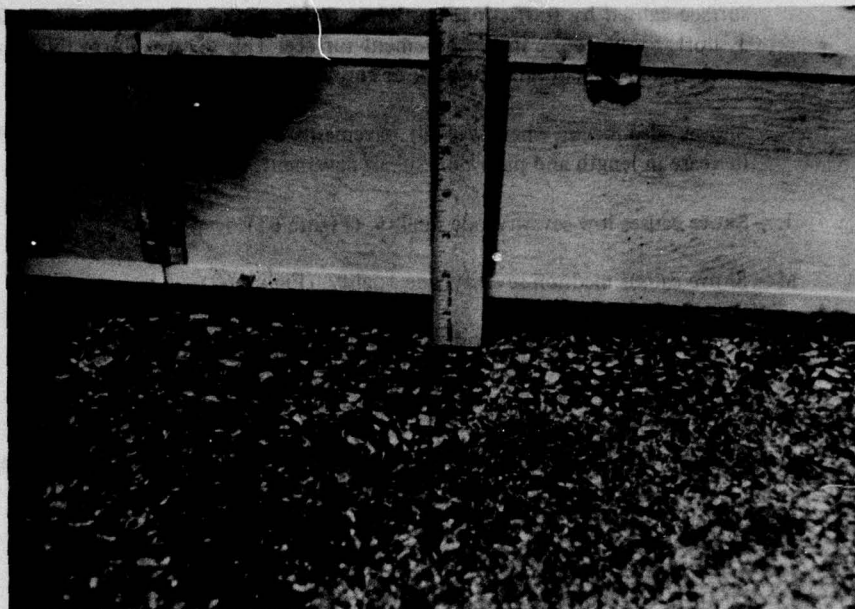




**Figure 58.** Low-severity rutting.



**Figure 59.** Medium-severity rutting.



**Figure 60.** High-severity rutting.





**Name of Distress:** Shoving

**Description:** Shoving is a permanent, longitudinal displacement of a localized area of the pavement surface caused by traffic loading. When traffic pushes against the pavement, it produces a short, abrupt wave in the pavement surface. This distress normally occurs only in unstable liquid asphalt mix (cutback or emulsion) pavements.

Shoves also occur where asphalt pavements abut PCC pavements; the PCC pavements increase in length and push the asphalt pavement, causing the shoving.

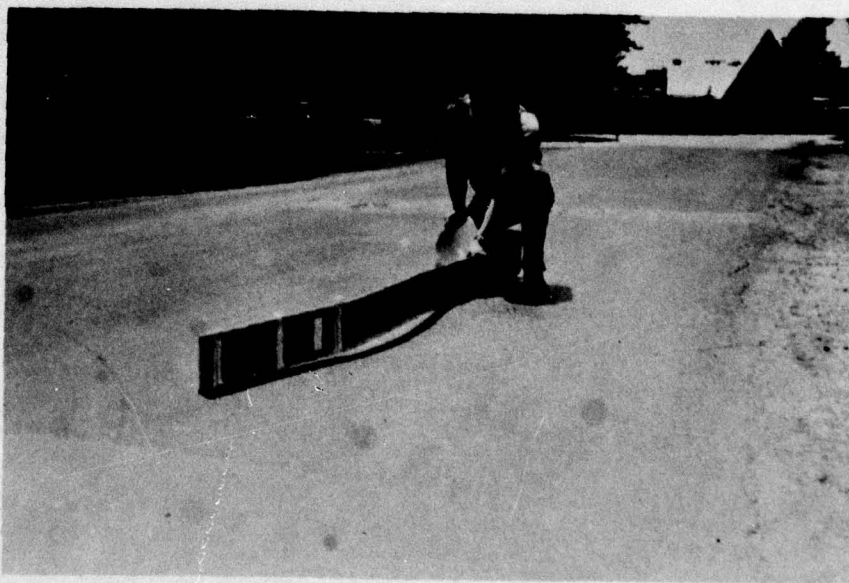
**Severity Levels:** L – Shove causes low-severity ride quality. (Figure 61)

M – Shove causes medium-severity ride quality. (Figure 62)

H – Shove causes high-severity ride quality. (Figure 63)

**How to Measure:** Shoves are measured in square feet of surface area.

Shoves occurring in patches are considered in rating the patch, not as a separate distress.



**Figure 61.** Low-severity shoving.



**Figure 62.** Medium-severity shoving approaching high severity.



**Figure 63.** High-severity shoving.



**Name of Distress:** Slippage Cracking

**Description:** Slippage cracks are crescent or half-moon shaped cracks having two ends pointing away from the direction of traffic. They are produced when breaking or turning wheels cause the pavement surface to slide or deform. This distress usually occurs when there is a low-strength surface mix or a poor bond between the surface and the next layer of the pavement structure.

**Severity Levels:** L – Average crack width is less than 3/8 in. (10 mm). (Figure 64)

M – One of the following conditions exist (Figure 65):

1. Average crack width is between 3/8 and 1½ in. (10 and 38 mm)
2. The area around the crack is broken into tight-fitting pieces.

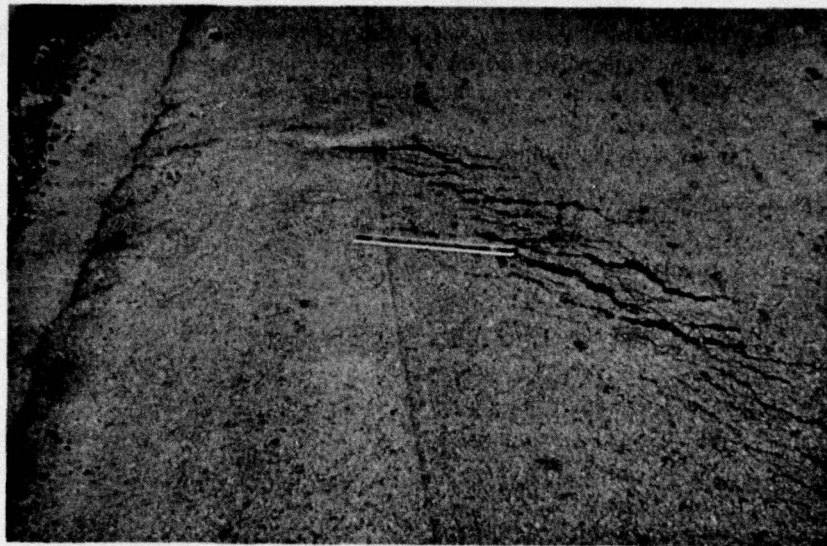
H – One of the following conditions exist (Figure 66):

1. The average crack width is greater than 1½ in. (38 mm)
2. The area around the crack is broken into easily removed pieces.

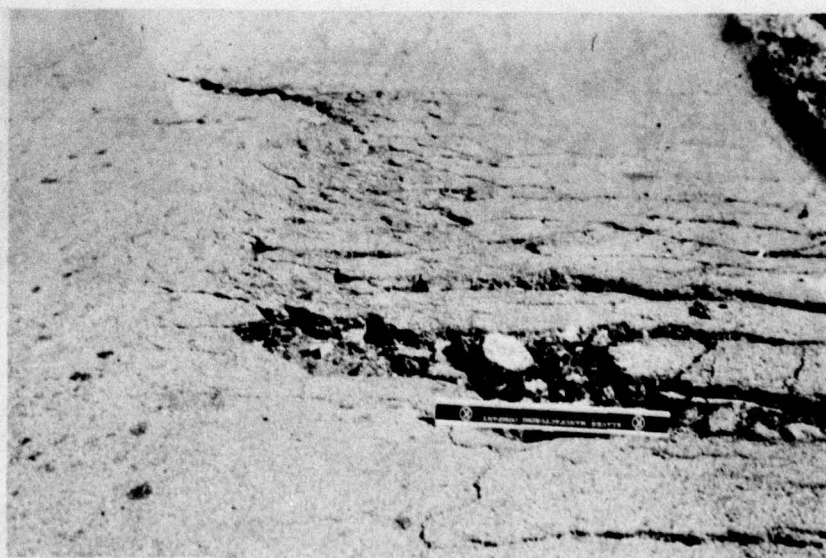
**How to Measure:** The area associated with a given slippage crack is measured in square feet and rated according to the highest level severity in the area.



**Figure 64.** Low-severity slippage cracking.



**Figure 65.** Medium-severity slippage cracking.



**Figure 66.** High-severity slippage cracking.



**Name of Distress:** Swell

**Description:** Swell is characterized by an upward bulge in the pavement's surface—a long, gradual wave of more than 10 ft (3 m) long. Swelling can be accompanied by surface cracking. This distress is usually caused by frost action in the subgrade or by swelling soil.

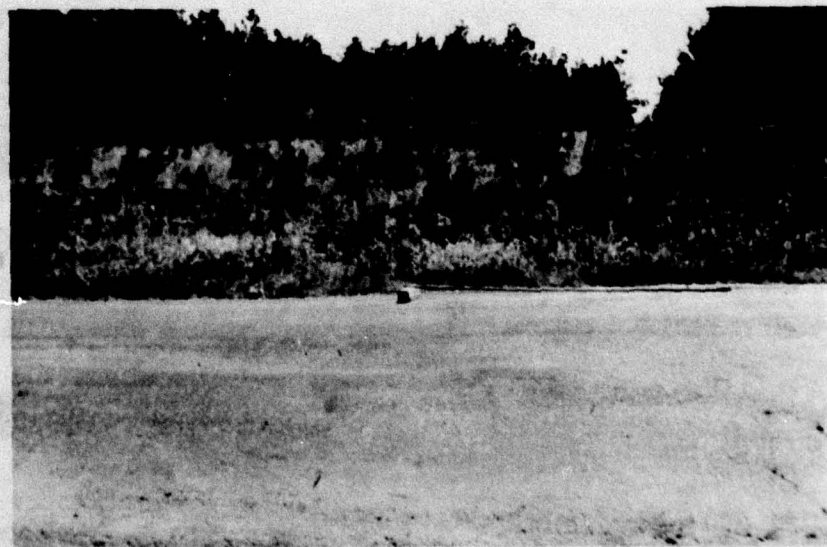
**Severity Levels:** L — Swell causes low-severity ride quality. Low-severity swells are not always easy to see, but can be detected by driving at the speed limit over the pavement section. An upward acceleration will occur at the swell if it is present.

M — Swell causes medium-severity ride quality.

H — Swell causes high-severity ride quality.

See Figure 67.

**How to Measure:** The surface area of the swell is measured in square feet.



**Figure 67.** Example swell. Severity level is based on ride quality criteria.

**Name of Distress:** Weathering and Raveling

**Description:** Weathering and raveling are the wearing away of the pavement surface caused by the loss of asphalt or tar binder and dislodged aggregate particles. These distresses indicate that either the asphalt binder has hardened appreciably or that a poor quality mixture is present. In addition, raveling may be caused by certain types of traffic, e.g., tracked vehicles.

**Severity Levels:** L – Aggregate or binder has started to wear away. In some areas, the surface is starting to pit. (Figures 68 and 69)

M – Aggregate and/or binder has worn away. The surface texture is moderately rough and pitted. (Figures 70 and 71)

H – Aggregate and/or binder has been considerably worn away. The surface texture is very rough and severely pitted. The pitted areas are less than 4 in. (10 mm) in diameter and less than 1/2 in. (13 mm) deep; pitted areas larger than this are counted as potholes. (Figure 72)

**How to Measure:** Weathering and raveling are measured in square feet of surface area.

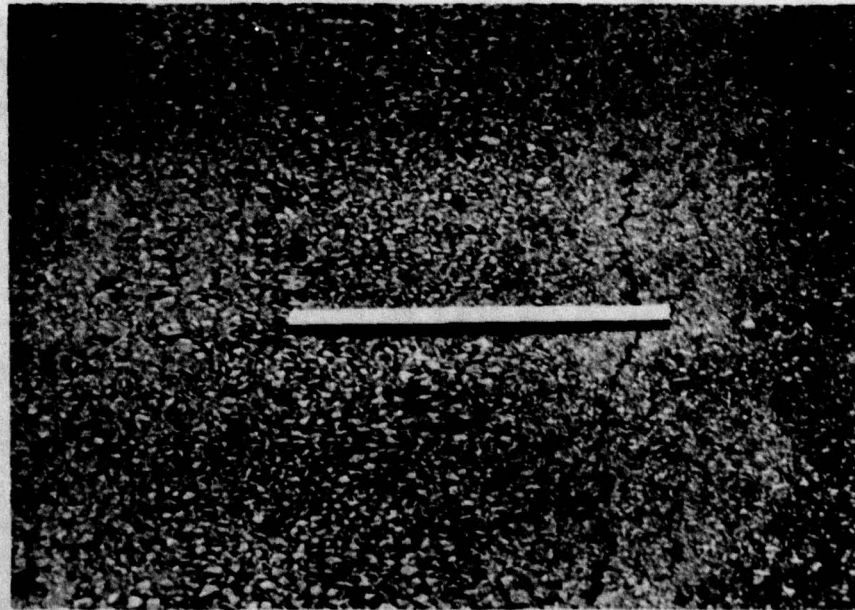
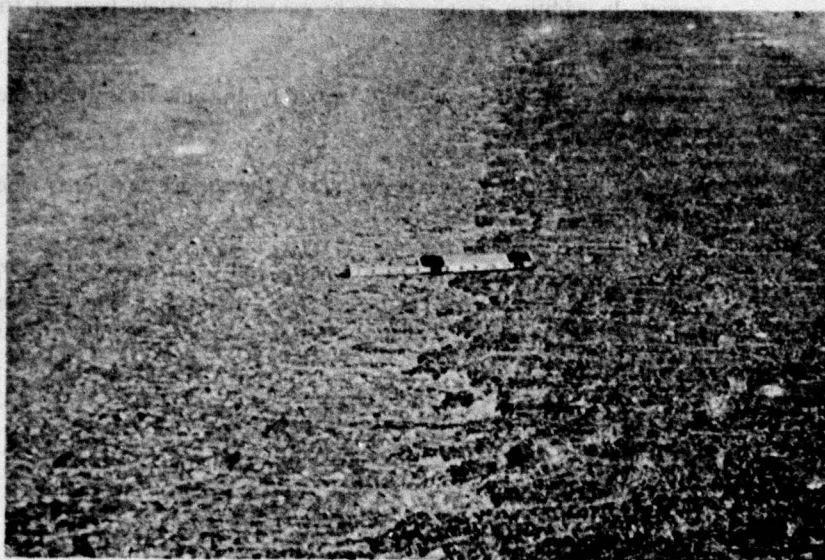
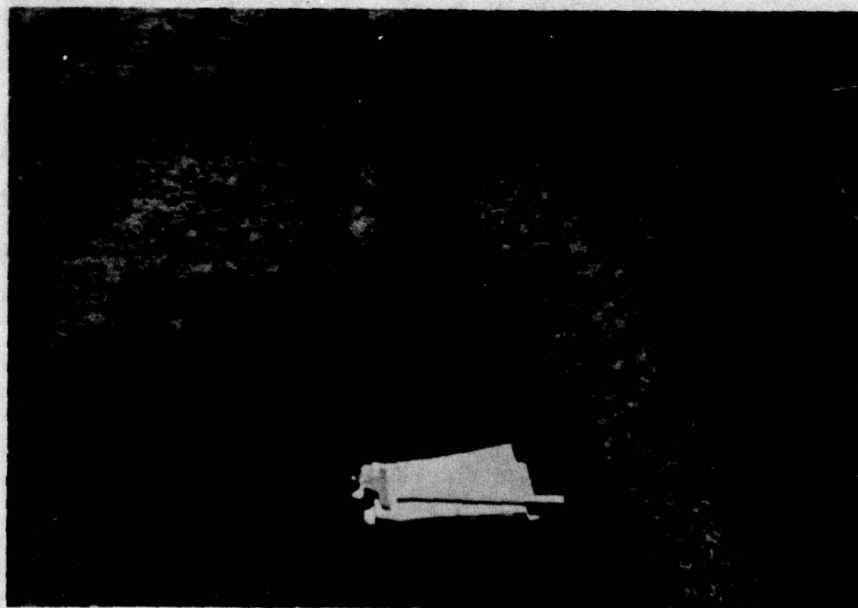


Figure 68. Low-severity weathering and raveling.

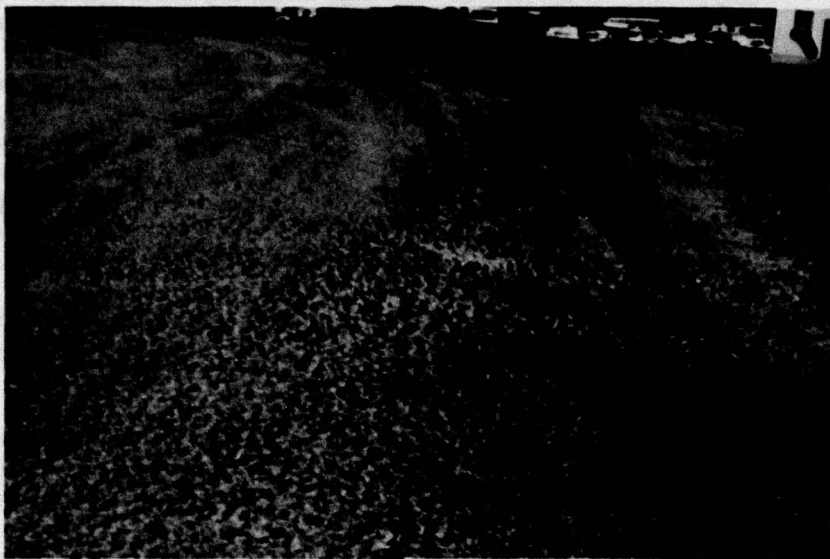




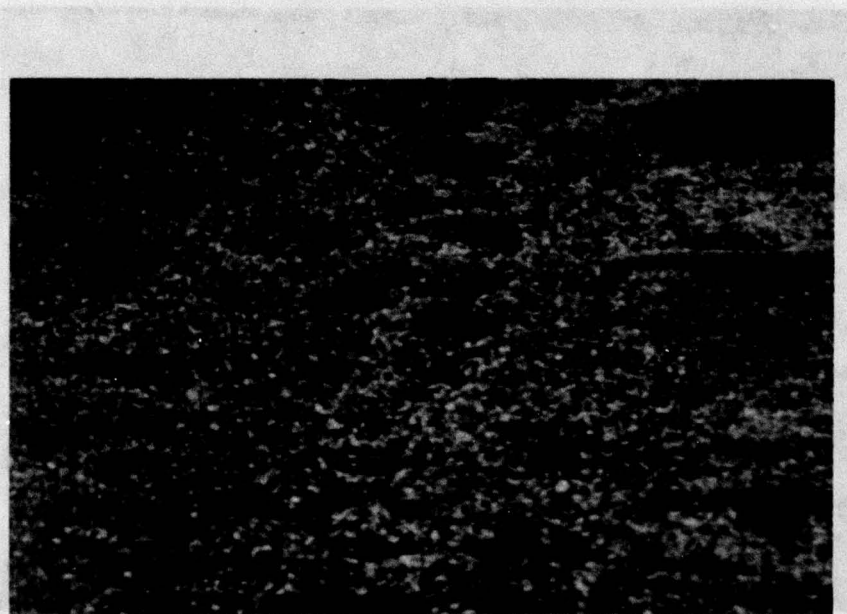
**Figure 69.** Low-severity weathering and raveling caused by tracked vehicles.



**Figure 70.** Medium-severity weathering and raveling.



**Figure 71. Medium-severity weathering and raveling.**



**Figure 72. High-severity weathering and raveling.**



### 3 DISTRESS IN JOINTED CONCRETE PAVEMENTS

#### General

Nineteen distress types for jointed concrete pavements are listed alphabetically on pp 65 through 115. Distress definitions apply to both plain and reinforced jointed concrete pavements, with the exception of linear cracking distress, which is defined separately for plain and reinforced jointed concrete.

During the field condition surveys and validation of the PCI, several questions were often asked regarding the identification and counting method of some of the distresses. The answers to these questions are included under the section titled "How to Count" for each distress. For convenience, however, items that are frequently referenced are listed below:

1. Faulting is counted only at joints. Faulting associated with cracks is not counted separately since faulting is incorporated into the severity-level definitions of cracks. Crack definitions are also used in defining corner breaks and divided slabs.

2. Joint seal damage is not counted on a slab-by-slab basis. Instead, a severity level is assigned based on the overall condition of the joint seal in the area.

3. Cracks in reinforced concrete slabs that are less than 1/8 in. (3 mm) wide are counted as shrinkage cracks. Shrinkage cracks should not be used to determine if the slab is broken into four or more pieces.

4. If the original distress of a patch is more severe than the patch, the original distress is the distress type recorded. For example, although patch material is present on the scaled area of the slab illustrated in Figure 73, only the scaling is counted.

5. Low-severity scaling (i.e., crazing) should only be counted if there is evidence that future scaling is likely to occur.

The above is not intended to be a complete list. To properly measure each distress type, the inspector must be familiar with its individual criteria.

The severity level of blow-up and railroad distress in jointed concrete pavements is rated according to the distress's effect on ride quality (see Chapter 1).



Figure 73. Distress in jointed concrete pavements.

## ALPHABETICAL LISTING OF DISTRESS TYPES

**Name of Distress:** Blow-up/Buckling

**Description:** Blow-ups or buckles occur in hot weather, usually at a transverse crack or joint that is not wide enough to permit slab expansion. The insufficient width is usually caused by infiltration of incompressible materials into the joint space. When expansion cannot relieve enough pressure, a localized upward movement of the slab edges (buckling) or shattering will occur in the vicinity of the joint. Blow-ups can also occur at utility cuts and drainage inlets.

**Severity Levels:** L — Buckling or shattering causes low-severity ride quality. (Figure 74)

M — Buckling or shattering causes medium-severity ride quality. (Figures 75 and 76)

H — Buckling or shattering causes high-severity ride quality. (Figure 77)

**How to Count:** At a crack, a blow-up is counted as being in one slab. However, if the blow-up occurs at a joint and affects two slabs, the distress should be recorded as occurring in two slabs. When a blow-up renders the pavement inoperable, it should be repaired immediately.



**Figure 74.** Low-severity blow-up/buckling.

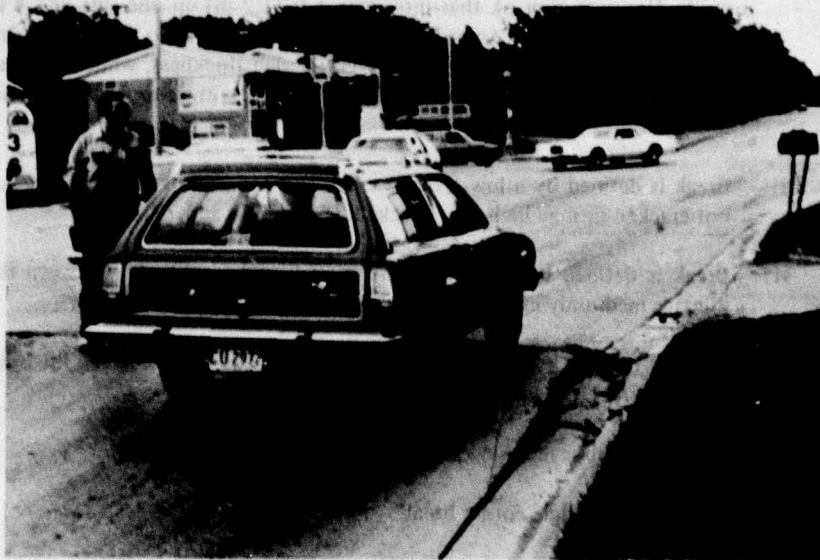




**Figure 75.** Medium-severity blow-up/buckling.



**Figure 76.** Medium-severity blow-up/buckling.



**Figure 77.** High-severity blow-up/buckling approaching inoperative condition.



**Name of Distress:** Corner Break

**Description:** A corner break is a crack that intersects the joints at a distance less than or equal to one-half the slab length on both sides, measured from the corner of the slab. For example, a slab with dimensions of 12 by 20 ft (3.7 by 6.1 m) that has a crack 5 ft (1.5 m) on one side and 12 ft (3.7 m) on the other side is not considered a corner break; it is a diagonal crack. However, a crack that intersects 4 ft (1.2 m) on one side and 8 ft (2.4 m) on the other is considered a corner break. A corner break differs from a corner spall in that the crack extends vertically through the entire slab thickness, while a corner spall intersects the joint at an angle. Load repetition combined with loss of support and curling stresses usually causes corner breaks.

**Severity Levels:**

- L\* – Break is defined by a low-severity crack and the area between the break and the joints is not cracked or may be lightly cracked. (Figures 78 and 79)
- M\* – Break is defined by medium-severity crack and or the area between the break and the joints is mediumly cracked. (Figure 80)
- H\* – Break is defined by a high-severity crack and/or the area between the break and the joints is highly cracked. (Figure 81)

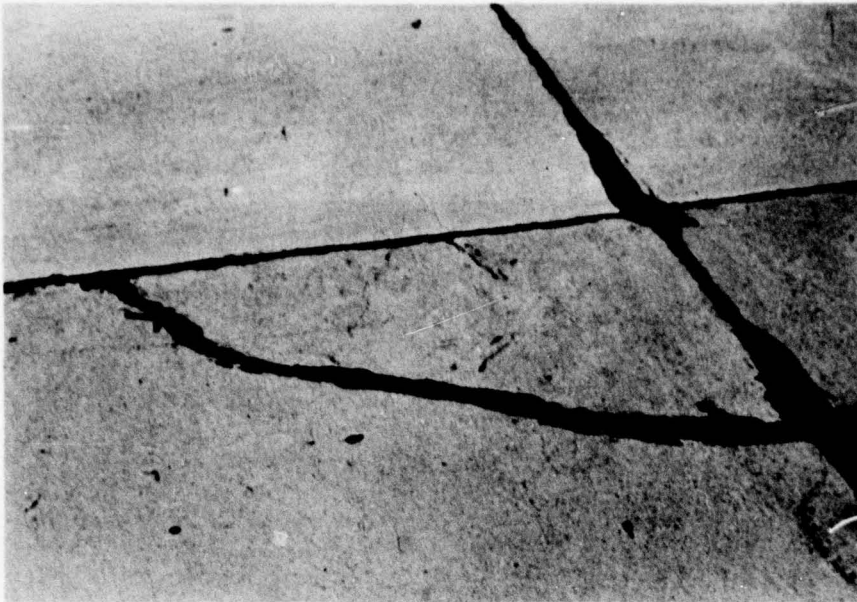
**How to Count:** Distressed slab is recorded as one slab if it:

1. Contains a single corner break.
2. Contains more than one break of a particular severity.
3. Contains two or more breaks of different severities.

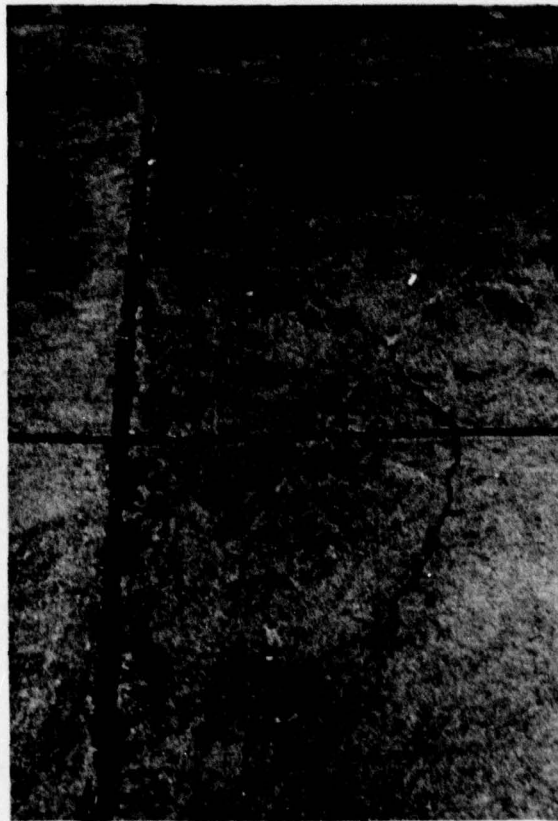
For two or more breaks, the highest level of severity should be recorded. For example, a slab containing both low- and medium-severity corner breaks should be counted as one slab with a medium corner break.

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\*See linear cracking for a definition of low-, medium-, and high-severity cracks.

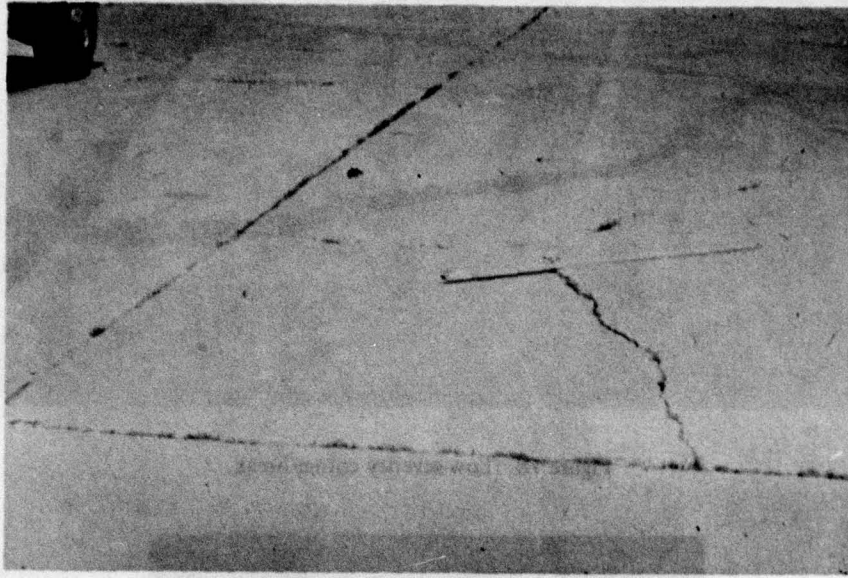


**Figure 78.** Low-severity corner break.

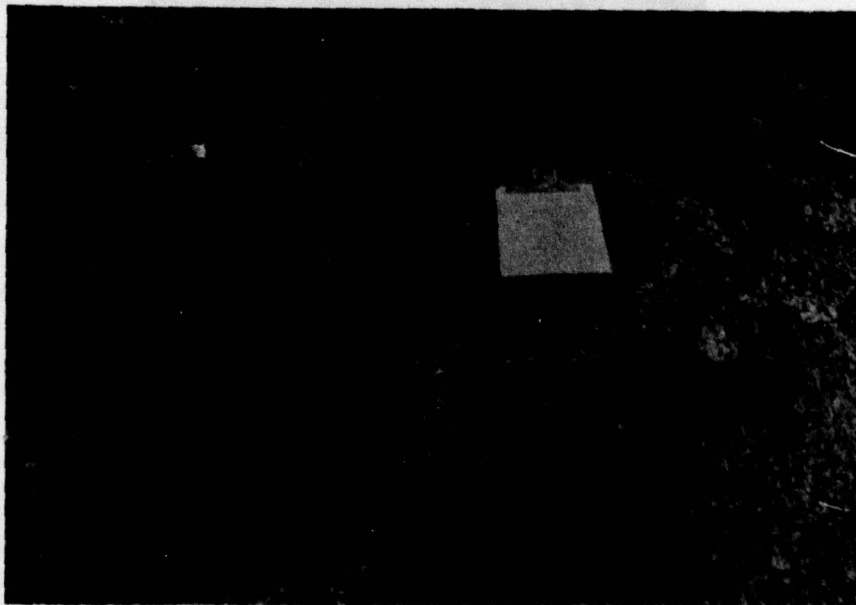


**Figure 79.** Low-severity corner break.





**Figure 80.** Medium-severity corner break. Defined by a medium-severity crack.



**Figure 81.** High-severity corner break.

**Name of Distress:** Divided Slab

**Description:** Slab is divided by cracks into four or more pieces due to overloading and/or inadequate support. If all pieces or cracks are contained within a corner break, the distress is categorized as a severe corner break.

**Severity Levels:**

**Severity of  
Majority of  
Cracks**

**Number of Pieces  
in Cracked Slab**

**4 to 5**

**6 to 8**

**More than 8**

**L**

**L**

**L**

**M**

**M**

**M**

**M**

**H**

**H**

**M**

**H**

**H**

See Figures 82 through 86.

**How to Count:**

If the slab is medium or high severity, no other distress is counted.

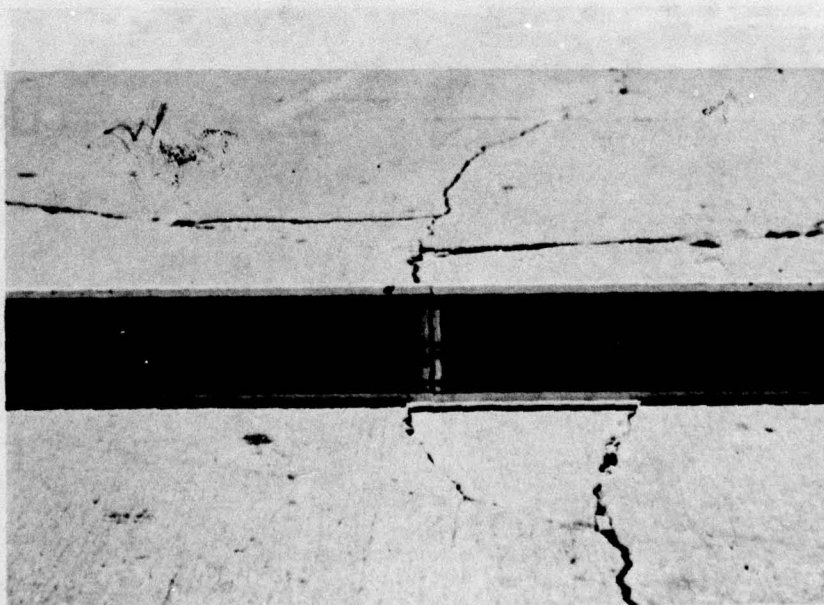


**Figure 82.** Low-severity divided slab. Majority of cracks are low severity (less than ½ in. wide and no faulting).





**Figure 83.** Medium-severity divided slab.



**Figure 84.** High-severity divided slab caused by high-severity cracks.



**Figure 85.** High-severity divided slab.



**Figure 86.** High-severity divided slab.



**Name of Distress:** Durability ("D") Cracking

**Description:** "D" cracking is caused by freeze-thaw expansion of the large aggregate which over time gradually breaks down the concrete. This distress usually appears as a pattern of cracks running parallel and close to a joint or linear crack. Since the concrete becomes saturated near joints and cracks, a dark-colored deposit can usually be found around fine "D" cracks. This type of distress may eventually lead to disintegration of the entire slab.

**Severity Levels:** L – "D" cracks cover less than 15 percent of slab area. Most of the cracks are tight, but a few pieces may have popped out. (Figures 87 and 88)

M – One of the following conditions exist (Figure 89):

1. "D" cracks cover less than 15 percent of the area and most of the pieces have popped out or can be easily removed.
2. "D" cracks cover more than 15 percent of the area. Most of the cracks are tight, but a few pieces may have popped out or can be easily removed.

H – "D" cracks cover more than 15 percent of the area and most of the pieces have popped out or can be easily removed. (See Figures 90 and 91)

**How to Count:** When the distress is located and rated at one severity, it is counted as one slab. If more than one severity level exists, the slab is counted as having the higher severity distress. For example, if low and medium "D" cracking are on the same slab, the slab is counted as having medium-severity cracking only.

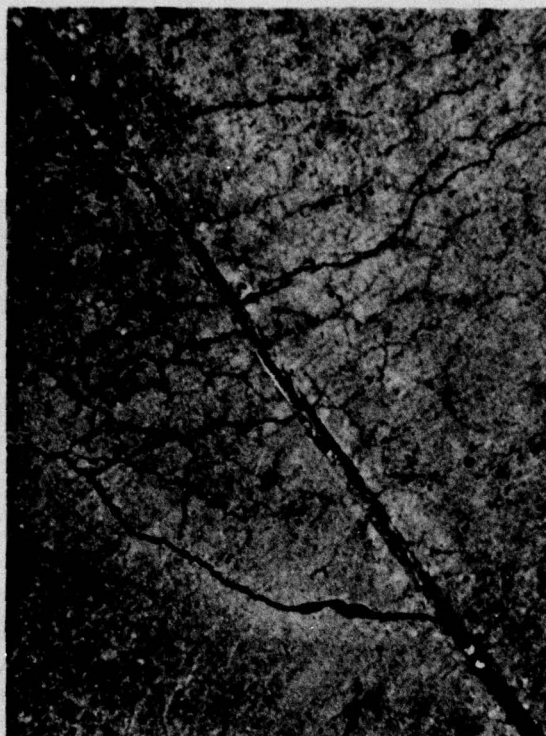


Figure 87. Low-severity durability cracking.

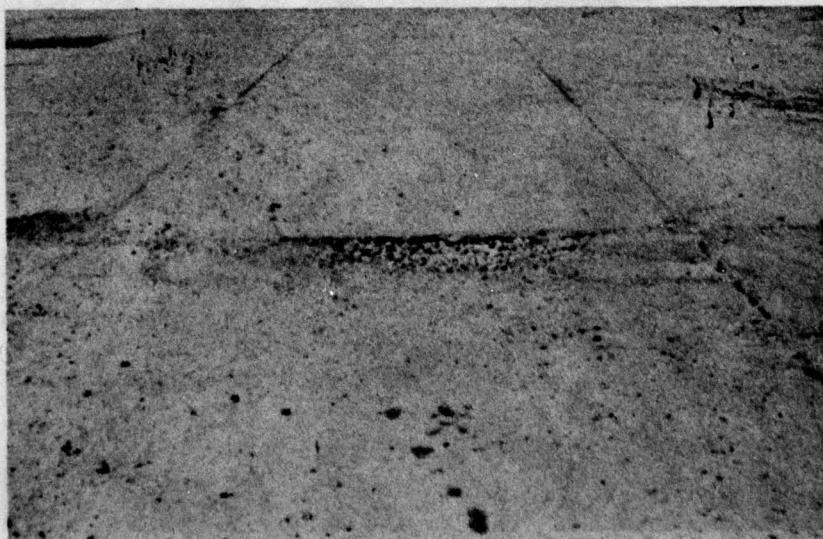


Figure 88. Low-severity durability cracking.





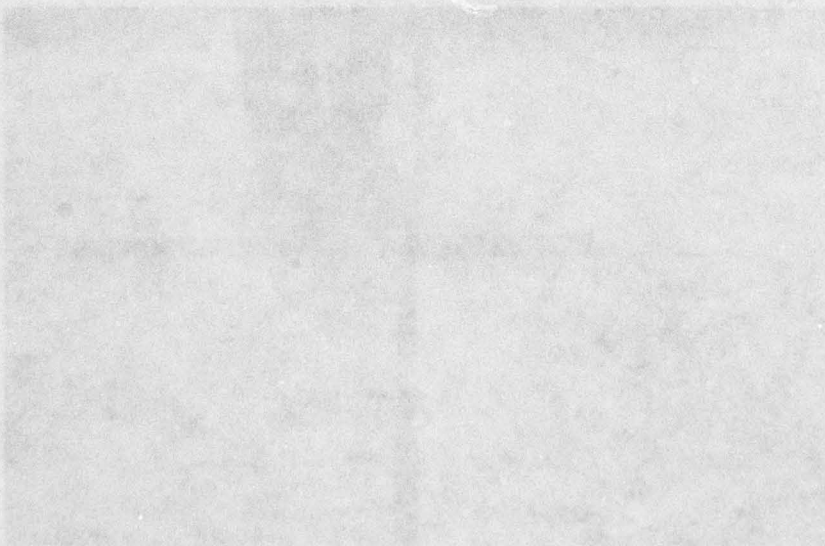
**Figure 89.** Medium-severity durability cracking.



**Figure 90.** High-severity durability cracking.



**Figure 91.** High-severity durability cracking.





**Name of Distress:** Faulting

**Description:** Faulting is the difference in elevation across a joint. Some of the common causes of faulting are:

1. Settlement because of soft foundation.
2. Pumping or eroding of material from under the slab.
3. Curling of the slab edges due to temperature and moisture changes.

**Severity Levels:** Severity levels are defined by the difference in elevation across the crack or joint.

Severity Level	Difference in Elevation
L	1/8 to 3/8 in. (3 to 10 mm)
M	3/8 to 3/4 in. (10 to 19 mm)
H	> 3/4 in. (> 19 mm)

See Figures 92 through 95.

**How to Count:** Faulting across a joint is counted as one slab. Only affected slabs are counted.

Faults across a crack are not counted as distress, but are considered when defining crack severity.



**Figure 92.** Low-severity faulting.

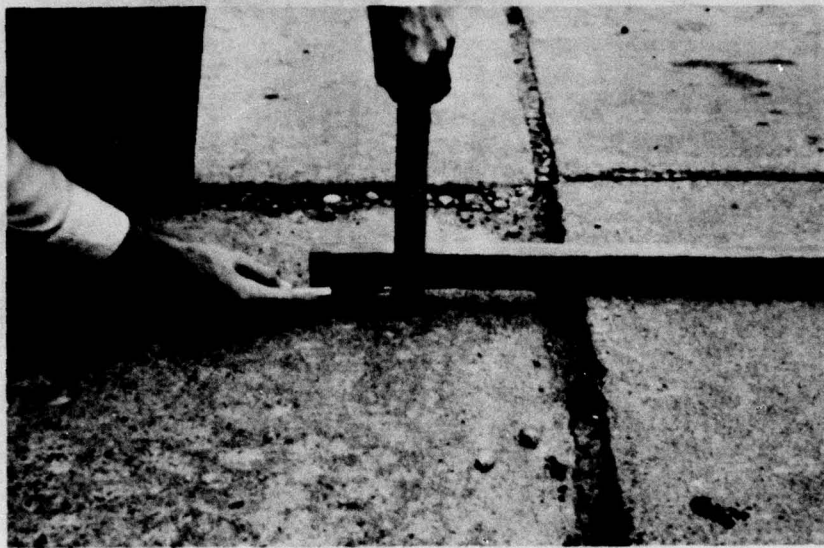


**Figure 93.** Medium-severity faulting.



**Figure 94.** Medium-severity faulting.





**Figure 95.** High-severity faulting.

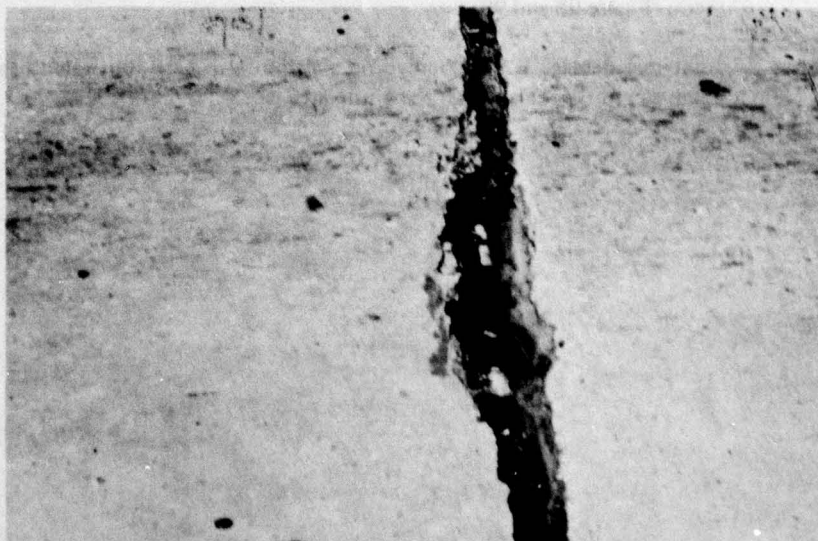


<b>Name of Distress:</b>	Joint Seal Damage
<b>Description:</b>	<p>Joint seal damage is any condition which enables soil or rocks to accumulate in the joints or allows significant water infiltration. Accumulation of incompressible materials prevents the slabs from expanding and may result in buckling, shattering, or spalling. A pliable joint filler bonded to the edges of the slabs protects the joints from material accumulation and prevents water from seeping down and softening the foundation supporting the slab.</p> <p>Typical types of joint seal damage are:</p> <ol style="list-style-type: none"> <li>1. Stripping of joint sealant.</li> <li>2. Extrusion of joint sealant.</li> <li>3. Weed growth.</li> <li>4. Hardening of the filler (oxidation).</li> <li>5. Loss of bond to the slab edges.</li> <li>6. Lack or absence of sealant in the joint.</li> </ol>
<b>Severity Levels:</b>	<p>L – Joint sealant is in generally good condition throughout the section. Sealant is performing well, with only minor damage (see above). (Figure 96)</p> <p>M – Joint sealant is in generally fair condition over the entire section, with one or more of the above types of damage occurring to a moderate degree. Sealant needs replacement within 2 years. (Figure 97)</p> <p>H – Joint sealant is in generally poor condition over the entire section, with one or more of the above types of damage occurring to a severe degree. Sealant needs immediate replacement. (Figure 98 and 99)</p>
<b>How to Count:</b>	Joint seal damage is not counted on a slab-by-slab basis, but rated based on the overall condition of the sealant over the entire area.

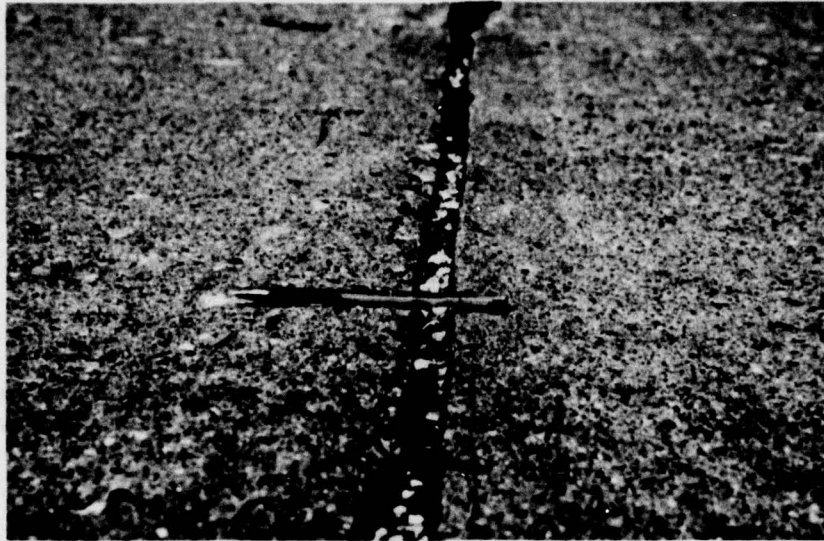




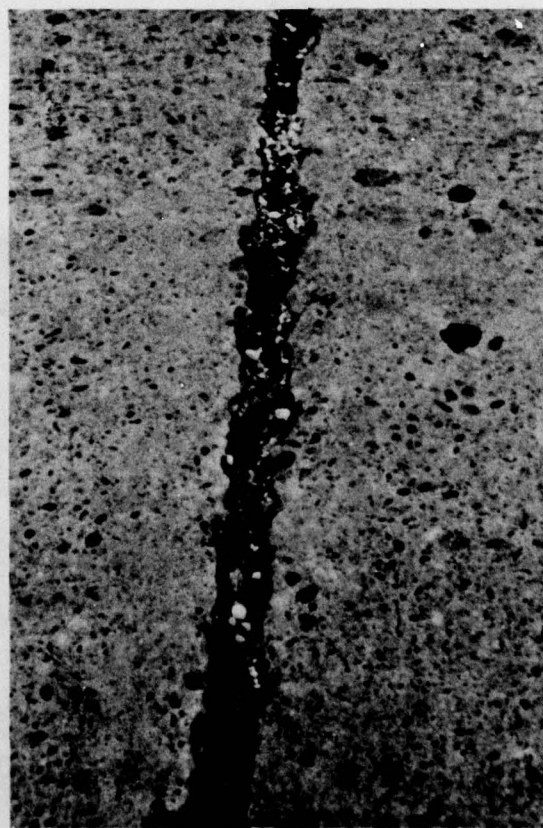
**Figure 96.** Low-severity joint seal damage.



**Figure 97.** Medium-severity joint seal damage.



**Figure 98.** High-severity joint seal damage.



**Figure 99.** High-severity joint seal damage.



**Name of Distress:** Lane/Shoulder Drop Off

**Description:** Lane/shoulder drop off is the difference between the settlement or erosion of the shoulder and the pavement travel-lane edge. The elevation difference can be a safety hazard; it can also cause increased water infiltration.

**Severity Levels:** L – The difference between the pavement edge and shoulder is 1 to 2 in. (25 to 51 mm). (Figure 100)

M – The difference in elevation is 2 to 4 in. (51 to 102 mm). (Figure 101)

H – The difference in elevation is greater than 4 in. (102 mm) (Figure 102)

**How to Count:** The mean lane/shoulder drop off is computed by averaging the maximum and minimum drop along the slab. Each slab exhibiting distress is measured separately and counted as one slab with the appropriate severity level.



**Figure 100.** Low-severity lane/shoulder drop off.



**Figure 101.** Medium-severity lane/shoulder drop off.



**Figure 102.** High-severity lane/shoulder drop off.



**Name of Distress:** Linear Cracking (Longitudinal, Transverse, and Diagonal Cracks)

**Description:** These cracks, which divide the slab into two or three pieces, are usually caused by a combination of repeated traffic loading, thermal gradient curling, and repeated moisture loading. (Slabs divided into four or more pieces are counted as Divided Slabs). Low-severity cracks are usually related to warp or friction and are not considered major structural distresses. Medium- or high-severity cracks are usually working cracks and are considered major structural distresses. (Figures 103 through 108)

Hairline cracks that are only a few feet long and do not extend across the entire slab are counted as shrinkage cracks.

**Severity Levels:** *Nonreinforced Slabs*

L – Nonfilled\* cracks less than or equal to 1/2 in. (12 mm) or filled cracks of any width with the filler in satisfactory condition. No faulting exists.

M – One of the following conditions exists:

1. Nonfilled crack with a width between 1/2 and 2 in. (12 and 51 mm).
2. Nonfilled crack of any width up to 2 in. (51 mm) with faulting of less than 3/8 in. (10 mm).
3. Filled crack of any width with faulting less than 3/8 in. (10 mm).

H – One of the following conditions exist:

1. Nonfilled crack with a width greater than 2 in. (51 mm).
2. Filled or nonfilled crack of any width with faulting greater than 3/8 in. (10 mm).

*Reinforced Slabs*

L – Nonfilled cracks with a width of 1/8 to 1 in. (3 to 25 mm); filled crack of any width with the filler in satisfactory condition. No faulting exists.

M – One of the following conditions exist:

1. Nonfilled cracks with a width between 1 and 3 in. (25 and 76 mm) and no faulting.
2. Nonfilled crack of any width up to 3 in. (76 mm) with up to 3/8 in. (10 mm) of faulting.
3. Filled crack of any width with faulting less than 3/8 in. (10 mm).

H – One of the following conditions exist:

1. Nonfilled crack with width over 3 in. (76 mm).
2. Filled or nonfilled crack of any width with faulting over 3/8 in. (10 mm).

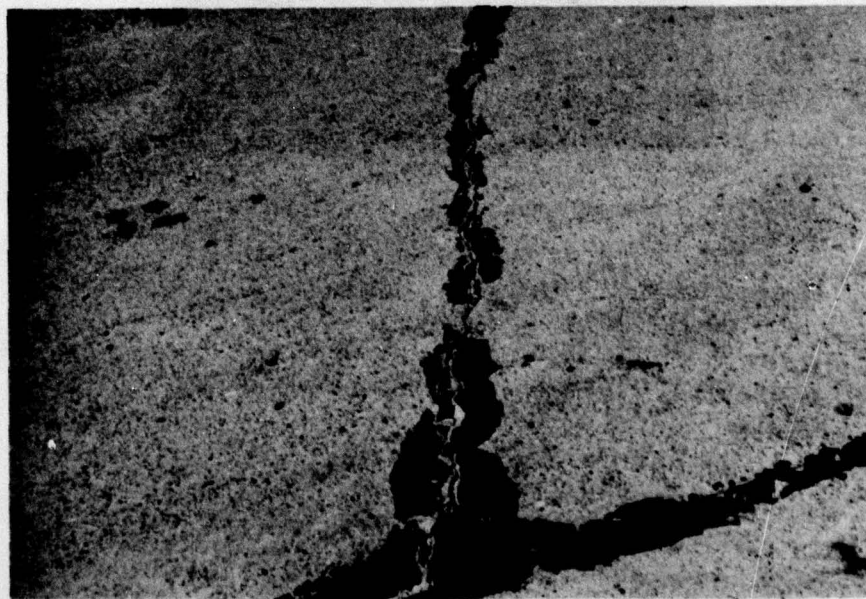
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\*Filled cracks where filler is unsatisfactory are treated as nonfilled.

**How to Count:**

Once the severity has been identified, the distress is recorded as one slab. If two medium-severity cracks are within one slab, the slab is counted as having one high-severity crack. Slabs divided into four or more pieces are counted as divided slabs.

In reinforced slabs, cracks with a width less than  $1/8$  in. (3 mm) are counted as shrinkage cracks. Slabs longer than 30 ft (9.1 m) are divided into approximately equal length "slabs" having imaginary joints assumed to be in perfect condition.



**Figure 103.** Low-severity linear cracking in a nonreinforced concrete slab.





**Figure 104.** Low-severity linear cracking in a nonreinforced concrete slab.



**Figure 105.** Medium-severity linear cracking in a reinforced concrete slab.





**Figure 106.** Medium-severity linear cracking in a reinforced concrete slab.



**Figure 107.** High-severity linear cracking in a nonreinforced concrete slab.



**Figure 108.** High-severity linear cracking in a nonreinforced concrete slab.



**Name of Distress:** Patching, Large [more than 5 sq ft (.45 m<sup>2</sup>)] and Utility Cuts

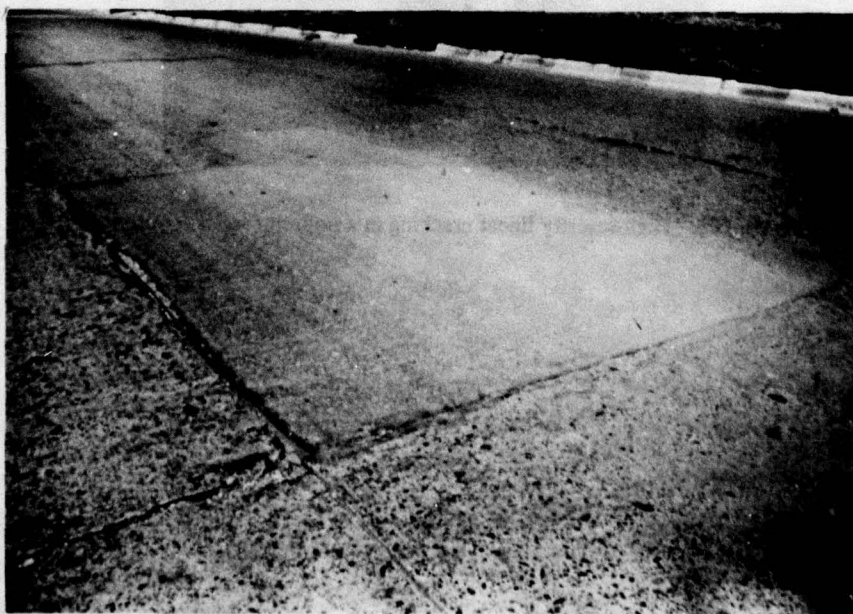
**Description:** A patch is an area where the original pavement has been removed and replaced by a filler material. A utility cut is a patch that has replaced the original pavement to allow the installation of underground utilities. The severity levels of a utility cut are the same as those for regular patching.

**Severity Levels:**

- L – Patch is functioning well, with little or no deterioration. (Figures 109 and 110)
- M – Patch is moderately deteriorated and/or moderate spalling can be seen around the edges. Patch material can be dislodged with considerable effort. (Figures 111 through 113)
- H – Patch is badly deteriorated. The extent of the deterioration warrants replacement of the patch. (Figure 114)

**How to Count:** If a single slab has one or more patches with the same severity level, it is counted as one slab containing that distress. If a single slab has more than one severity level, it is counted as one slab with the higher severity level.

If the cause of the patch is more severe, only the original distress is counted.



**Figure 109.** Low-severity patching, large and utility cuts.



**Figure 110.** Low-severity patching, large and utility cuts.



**Figure 111.** Medium-severity patching, large.





Figure 112. Medium-severity patching, large.

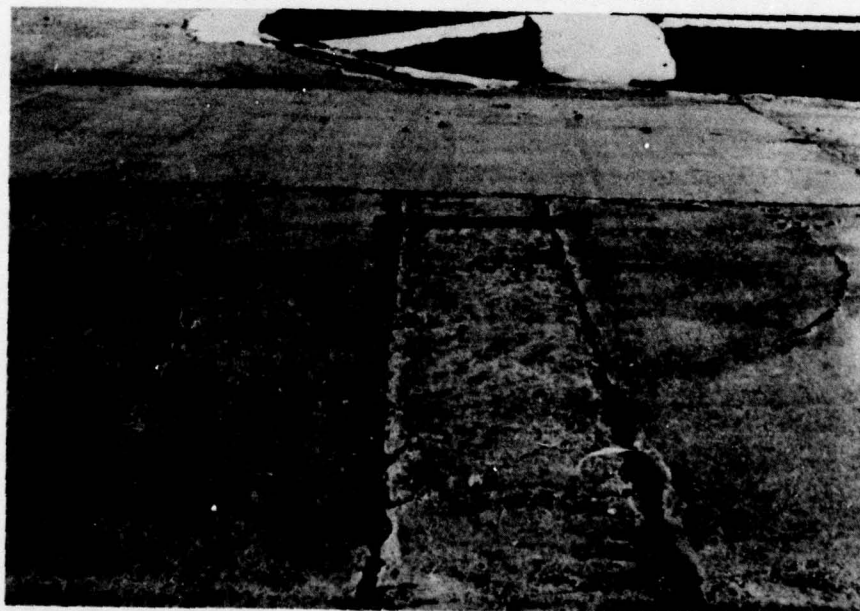


Figure 113. Medium-severity patching, utility cuts.

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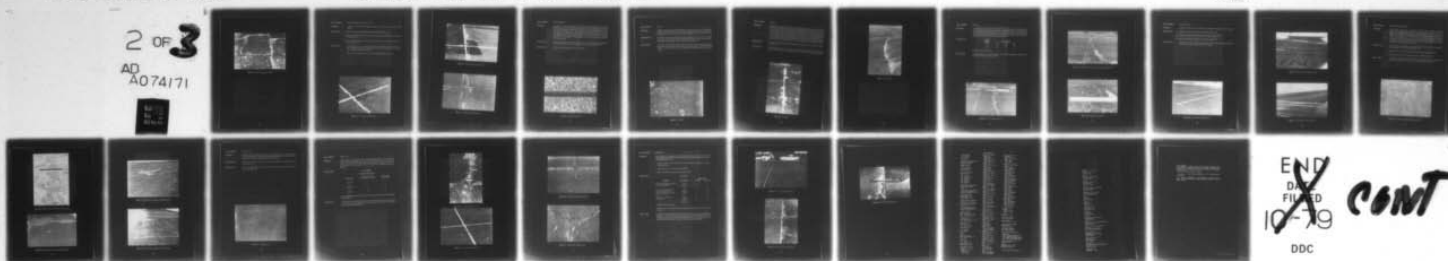
CONSTRUCTION ENGINEERING RESEARCH LAB (ARMY) CHAMPAIGN IL F/G 13/2  
DEVELOPMENT OF A PAVEMENT CONDITION RATING PROCEDURE FOR ROADS,--ETC(U)  
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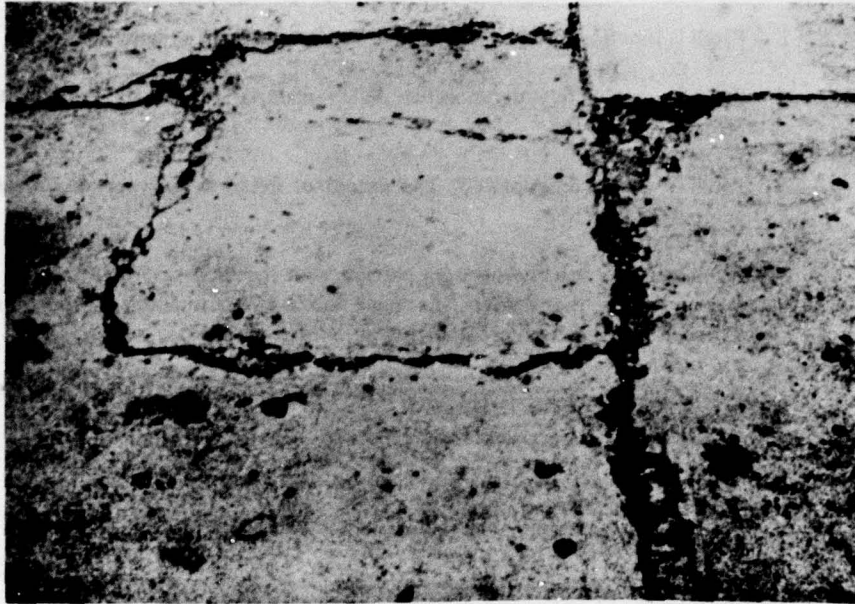
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**Figure 114.** High-severity patching, large.

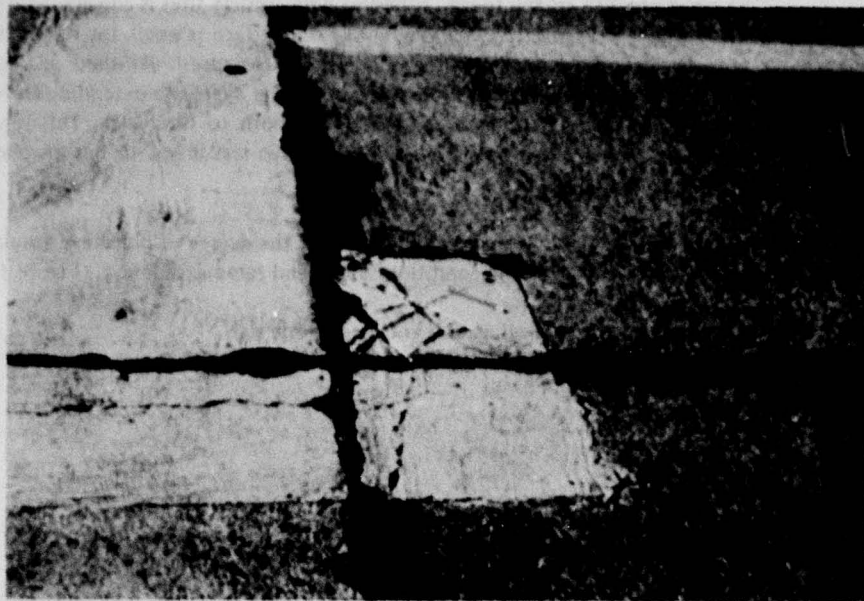


- Name of Distress:** Patching, Small [less than 5 sq ft (.45 m<sup>2</sup>)]
- Description:** A patch is an area where the original pavement has been removed and replaced by a filler material.
- Severity Levels:**
- L – Patch is functioning well with little or no deterioration. (Figure 115)
  - M – Patch is moderately deteriorated. Patch material can be dislodged with considerable effort. (Figure 116)
  - H – Patch is badly deteriorated. The extent of deterioration warrants replacement of the patch. (Figure 117)
- How to Count:** If a single slab has one or more patches with the same severity level, it is counted as one slab containing that distress. If a single slab has more than one severity level, it is counted as one slab with the higher severity level.
- If the cause of the patch is more severe, only the original distress is counted.

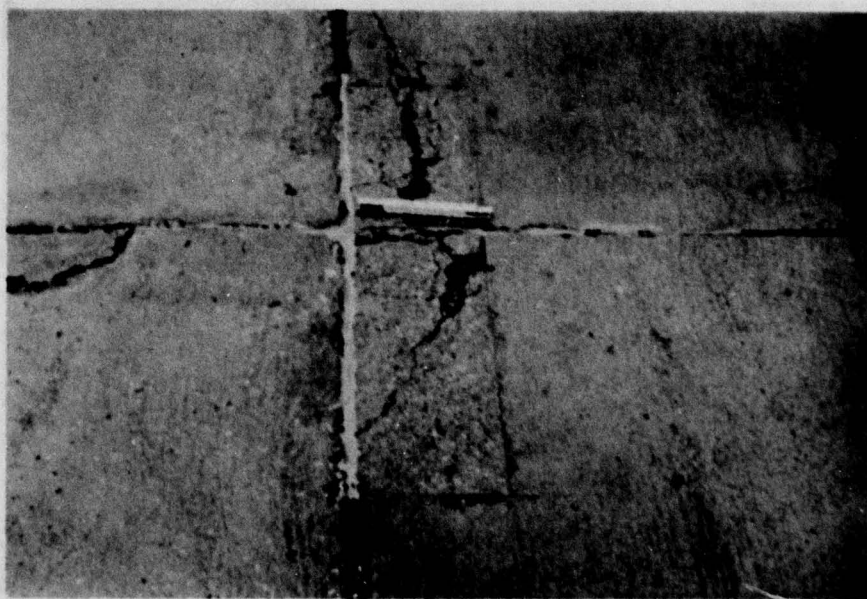


Figure 115. Low-severity patching, small.





**Figure 116.** Medium-severity patching, small.



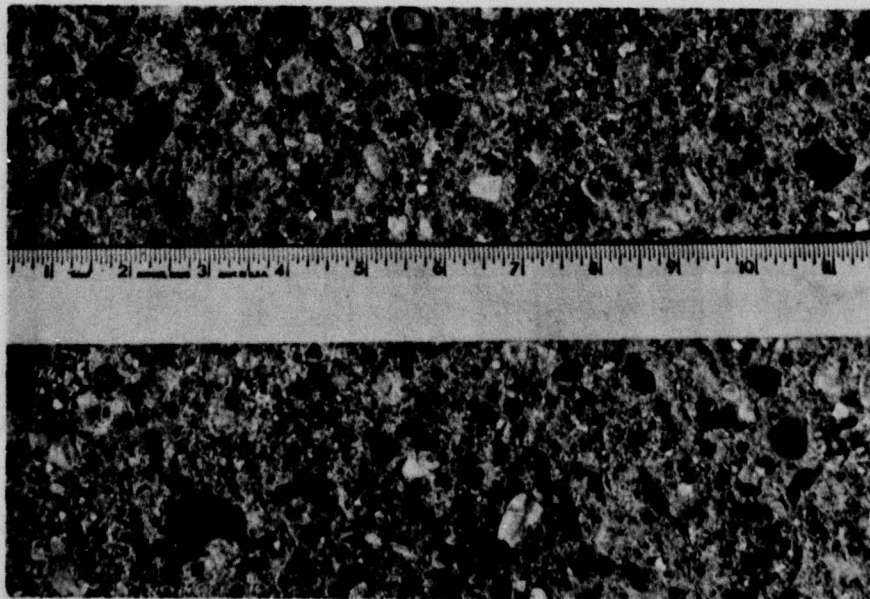
**Figure 117.** High-severity patching, small.

**Name of Distress:** Polished Aggregate

**Description:** This distress is caused by repeated traffic applications. When the aggregate in the surface becomes smooth to the touch, adhesion with vehicle tires is considerably reduced. When the portion of aggregate extending above the surface is small, the pavement texture does not significantly contribute to reducing vehicle speed. Polished aggregate should be counted when close examination reveals that the aggregate extending above the concrete is negligible, and the surface aggregate is smooth to the touch. This type of distress is indicated when the number on a skid resistance test is low or has dropped significantly from previous ratings.

**Severity Levels:** No degrees of severity are defined. However, the degree of polishing should be significant before it is included in the condition survey and rated as a defect. (Figure 118)

**How to Count:** A slab with polished aggregate is counted as one slab.



**Figure 118.** Polished aggregate.

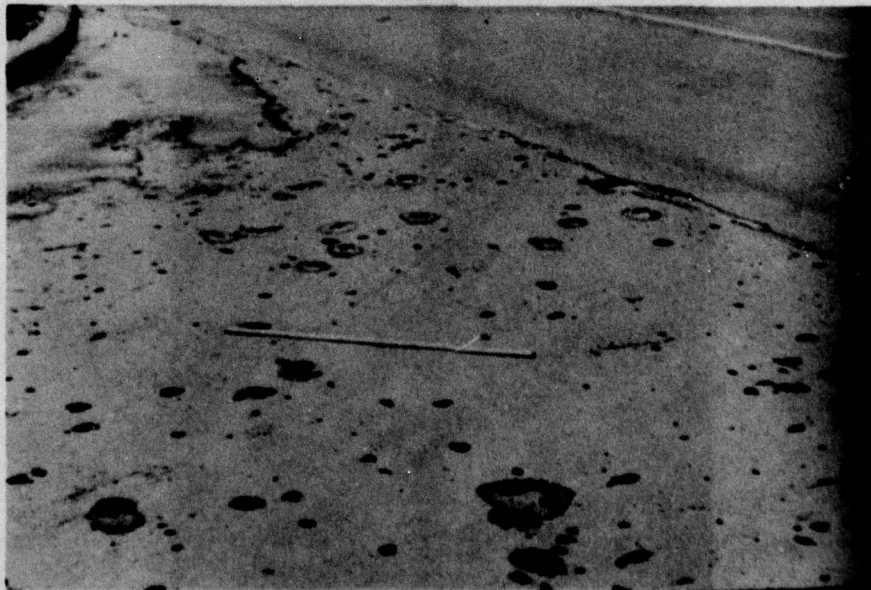


**Name of Distress:** Popouts

**Description:** A popout is a small piece of pavement that freeze-thaw action combined with aggregate expansion causes to break loose from the surface. Popouts usually range in diameter from approximately 1 to 4 in. (25 to 102 mm) and in depth from 1/2 to 2 in. (13 to 51 mm).

**Severity Levels:** No degrees of severity are defined for popouts. However, popouts must be extensive before they are counted as a distress. Average popout density must exceed approximately three popouts per square yard over the entire slab area. (Figure 119)

**How to Count:** The density of the distress must be measured. If there is any doubt that the average is greater than three popouts per square yard, at least three random 1 sq yd (.84 m<sup>2</sup>) areas should be checked. When the average is greater than this density, the slab should be counted.



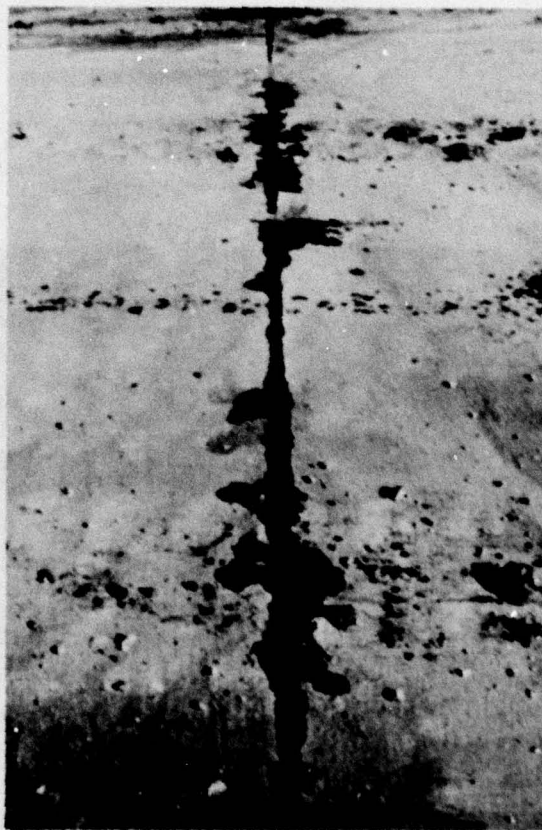
**Figure 119.** Popouts.

**Name of Distress:** Pumping

**Description:** Pumping is the ejection of material from the slab foundation through joints or cracks. This is caused by deflection of the slab by passing loads. As a load moves across the joint between the slabs, water is first forced under the leading slab, and then forced back under the trailing slab. This erodes and eventually removes soil particles, resulting in progressive loss of pavement support. Pumping can be identified by surface stains and evidence of base or subgrade material on the pavement close to joints or cracks. Pumping near joints is caused by poor joint sealer and indicates loss of support; repeated loading will eventually produce cracks. Pumping can also occur along the slab edge, causing loss of support.

**Severity Levels:** No degrees of severity are defined. It is sufficient to indicate the pumping exists. (Figures 120 and 121)

**How to Count:** One pumping joint between two slabs is counted as two slabs. However, if the remaining joints around the slab are also pumping, one slab is added per additional pumping joint.



**Figure 120.** Pumping.





**Figure 121.** Pumping.



**Name of Distress:** Punchout

**Description:** This distress is a localized area of the slab that is broken into pieces. The punchout can take many different shapes and forms, but it is usually defined by a crack and a joint, or two closely spaced cracks [usually 5 ft (1.52 m) wide]. This distress is caused by heavy repeated loads, inadequate slab thickness, loss of foundation support, and/or a localized concrete construction deficiency (e.g., honeycombing).

**Severity Levels:**

Majority of Cracks Severity	Number of Pieces		
	2 to 3	4 to 5	> 5
L	L	L	M
M	L	M	H
H	M	H	H

See Figures 122 through 124.

**How to Count:**

If a slab contains one or more punchouts, it is counted as containing a punchout at the severity level of the most severe punchout.



**Figure 122.** Low-severity punchout.





Figure 123. Medium-severity punchout approaching high severity.



Figure 124. High-severity punchout.

**Name of Distress:** Railroad Crossing

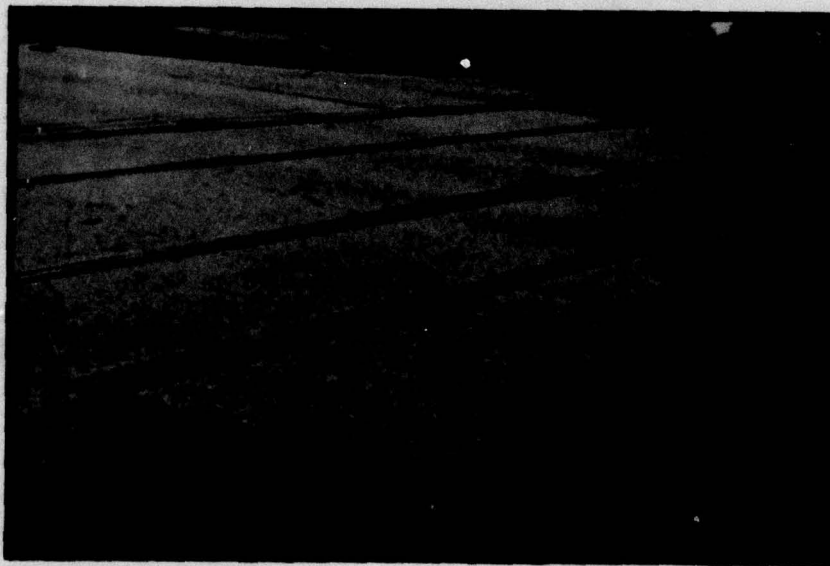
**Description:** Railroad crossing distress is characterized by depressions or bumps around the tracks.

**Severity Levels:** L – Railroad crossing causes low-severity ride quality. (Figure 125)

M – Railroad crossing causes medium-severity ride quality. (Figure 126)

H – Railroad crossing causes high-severity ride quality. (Figure 127)

**How to Count:** The number of slabs crossed by the railroad track is counted. Any large bump created by the tracks should be counted as part of the crossing.



**Figure 125.** Low-severity railroad crossing.





**Figure 126.** Medium-severity railroad crossing.



**Figure 127.** High-severity railroad crossing.

**Name of Distress:** Scaling/Map Cracking/Crazing

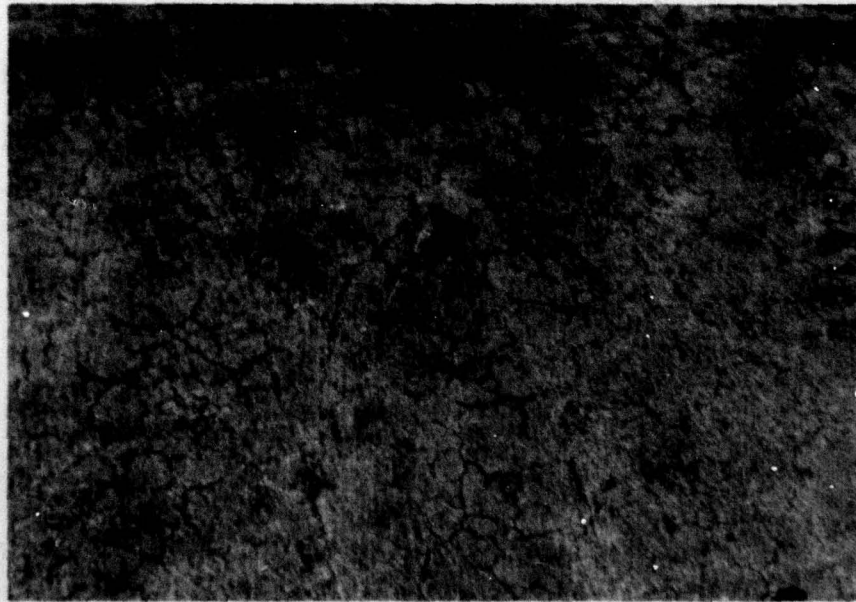
**Description:** Map cracking or crazing refers to a network of shallow, fine, or hairline cracks which extend only through the upper surface of the concrete. The cracks tend to intersect at angles of 120 degrees. Map cracking or crazing is usually caused by concrete over-finishing, and may lead to surface scaling, which is the breakdown of the slab surface to a depth of approximately 1/4 to 1/2 in. (6 to 13 mm). Scaling may also be caused by deicing salts, improper construction, freeze-thaw cycles, and poor aggregate. The type of scaling defined here is not caused by "D" cracking. If scaling is caused by "D" cracking, it should be counted under that distress only.

**Severity Levels:** L – Crazing or map cracking exists over most of the slab area; the surface is in good condition, with only minor scaling present. (Figure 128)

M – Slab is scaled, but less than 15 percent of the slab area is affected. (Figure 129)

H – Slab is scaled over more than 15 percent of its area. (Figures 130 and 132)

**How to Count:** A scaled slab is counted as one slab. Low-severity crazing should only be counted if the potential for scaling appears to be imminent, or few small pieces have come out.

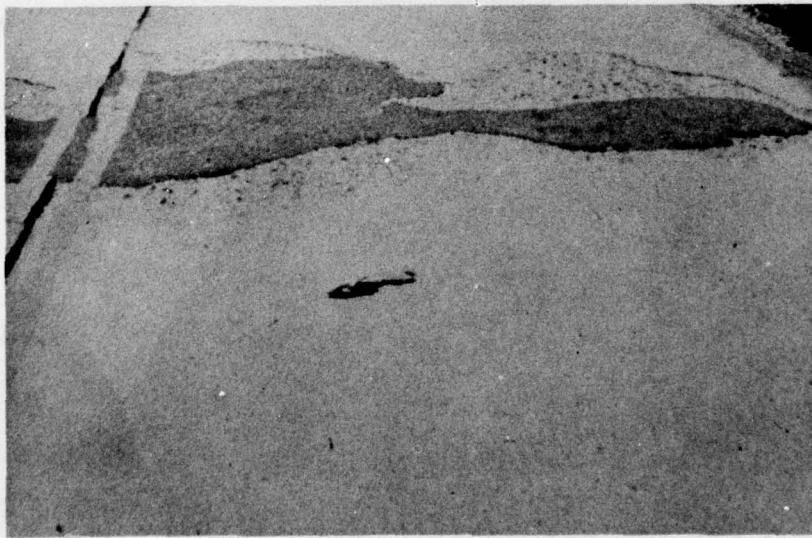


**Figure 128.** Low-severity scaling/map cracking/crazing.





**Figure 129.** Medium-severity scaling/map cracking/crazing.



**Figure 130.** High-severity scaling/map cracking/crazing.



**Figure 131.** High-severity scaling/map cracking/crazing.



**Figure 132.** High-severity scaling/map cracking/crazing.

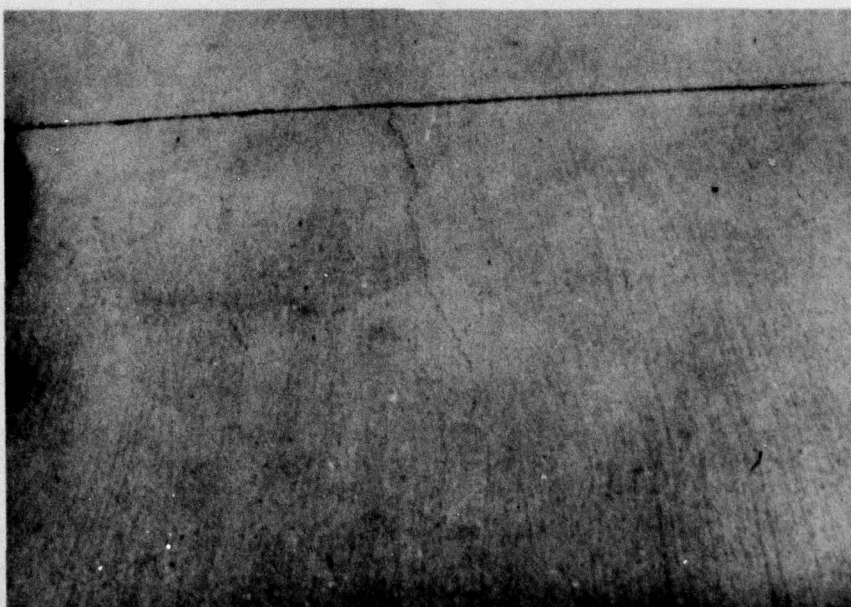


**Name of Distress:** Shrinkage Cracks

**Description:** Shrinkage cracks are hairline cracks that are usually only a few feet long and do not extend across the entire slab. They are formed during the setting and curing of the concrete and usually do not extend through the depth of the slab.

**Severity Levels:** No degrees of severity are defined. It is enough to indicate that shrinkage cracks are present. (Figure 133)

**How to Count:** If one or more shrinkage cracks exist on one particular slab, the slab is counted as one slab with shrinkage cracks.



**Figure 133.** Shrinkage cracks.

**Name of Distress:** Spalling, Corner

**Description:** Corner spalling is the breakdown of the slab within approximately 2 ft (.6 m) of the corner. A corner spall differs from a corner break in that the spall usually angles downward to intersect the joint, while a break extends vertically through the slab corner. Spalls less than 5 in. (13 mm) from the crack to the corner on both sides should not be counted.

**Severity Levels:**

Depth of Spall	Corner Spalling	
	Dimensions of Sides of Spall	
	5 x 5 in. to 12 x 12 in. (13 x 13 mm) (31 x 31 mm)	Over 12 x 12 in. (31 x 31 mm)
< 1 in. (25 mm)	L	L
1 to 2 in. (25 to 51 mm)	L	M
> 2 in. (51 mm)	M	H

Corner spalling having an area of less than 10 sq in. (516 mm<sup>2</sup>) is not counted. (Figures 134 through 137)

**How to Count:**

If one or more corner spalls with the same severity level are in a slab, the slab is counted as one slab with corner spalling. If more than one severity level occurs, it is counted as one slab with the higher severity level.



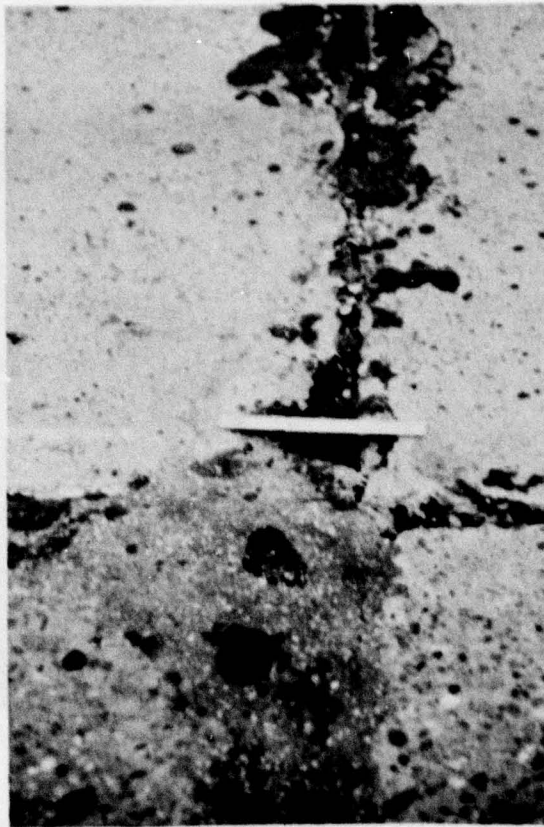
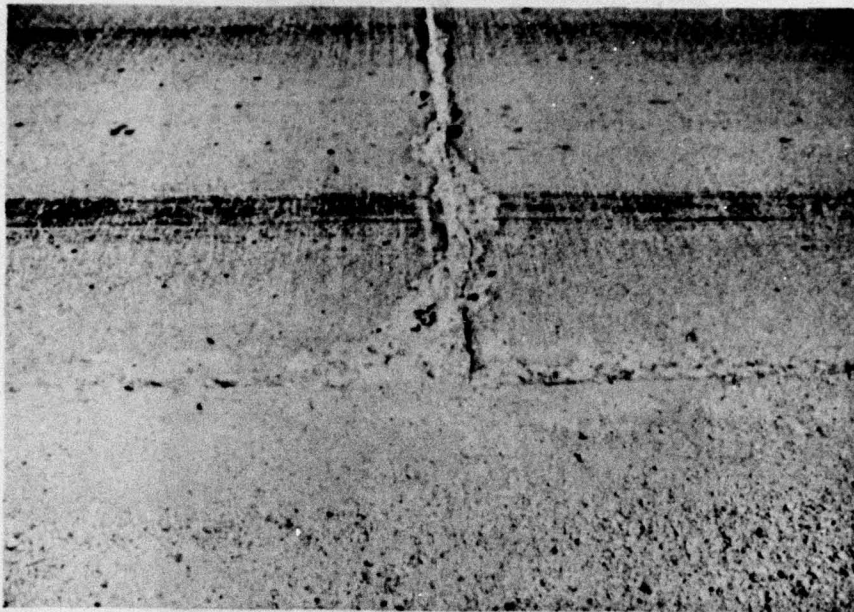


Figure 134. Low-severity spalling, corner.



Figure 135. Low-severity spalling, corner.



**Figure 136.** Medium-severity spalling, corner.



**Figure 137.** High-severity spalling, corner.



**Name of Distress:** Spalling, Joint

**Description:** Joint spalling is the breakdown of the slab edges within 2 ft (.6 m) of the joint. A joint spall usually does not extend vertically through the slab, but intersects the joint at an angle. Spalling results from:

1. Excessive stresses at the joint caused by traffic loading or by infiltration of incompressible materials.
2. Weak concrete at the joint caused by overworking.
3. Water accumulation in the joint and freeze-thaw action.

**Severity Levels:**

Spall Pieces	Joint Spalling		
	Width of Spall	Length of Spall	
		< 2 ft (.6 m)	> 2 ft (.6 m)
Tight—cannot be easily removed (may be a few pieces missing).	< 4 in. (102 mm)	L	L
	> 4 in.	L	L
Loose—can be removed and some pieces are missing; if most or all pieces are missing, spall is shallow, less than 1 in. (25 mm).	< 4 in. (102 mm)	L	M
	> 4 in. (102 mm)	L	M
Missing—most or all pieces have been removed.	< 4 in. (102 mm)	L	M
	> 4 in. (102 mm)	M	H

See Figures 138 through 140.

A frayed joint where the concrete has been worn away along the entire joint is rated as low severity.

**How to Count:**

If the joint is along the edge of one slab, it is counted as one slab with joint spalling. If spalling is on more than one edge of the same slab, the edge having the highest severity is counted and recorded as one slab. Joint spalling can also occur along the edges of two adjacent slabs. If this is the case, each slab is counted as having joint spalling.

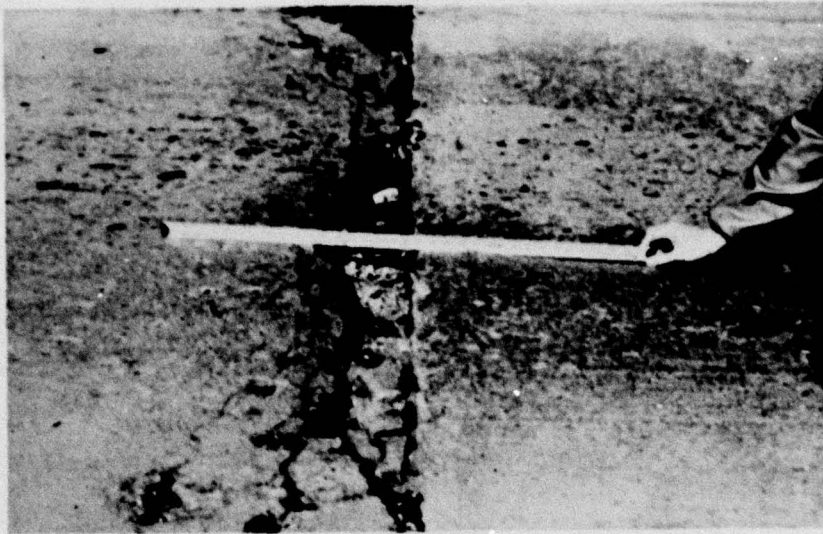


**Figure 138.** Low-severity spalling, joint.



**Figure 139.** Medium-severity spalling, joint.





**Figure 140.** High-severity spalling, joint.

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Development of a pavement condition rating procedure for roads, streets, and parking lots / by Mohamed Y. Shahin, Starr D. Kohn. -- Champaign, IL : Construction Engineering Research Laboratory ; Springfield, VA : available from NTIS, 1979.

2v. ; 27 cm. (Technical report ; M-268)

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1. Pavements -- evaluation. I. Kohn, Starr D. II. Title. III. Series: U.S. Army Construction Engineering Research Laboratory. Technical report ; M-268.



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CONSTRUCTION ENGINEERING RESEARCH LAB (ARMY) CHAMPAIGN IL F/6 13/2  
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Errata sheet for Technical Report M-268, *Development of a Pavement Condition Rating Procedure for Roads, Streets, and Parking Lots, Volume II: Distress Identification Manual*, by Mohamed Y. Shahin and Starr D. Kohn, July 1979, ADA074171.

Page 61, add the following sentence to the Description paragraph: "Softening of the surface and dislodging of the aggregates due to oil spillage is also included under raveling."

Page 61, Severity Levels: L - add the following: "In case of oil spillage, the oil stain can be seen but the surface is hard and cannot be penetrated with a coin."

M -, add the following: "In case of oil spillage, the surface is soft and can be penetrated with a coin."

H -, add the following: "In case of oil spillage the asphalt binder has lost its binding effect and the aggregate has become loose."

Page 64, line 3 of No. 3 in the second column, change the word "used" to "counted."